GROWING A GREEN GENERATION: DESIGNING EDUCATIONAL GARDENS FOR SCHOOLS

by

ERIN KEELY MCDONALD

(Under the Direction of Shelley Cannady)

ABSTRACT

All over the United States, learning gardens are being installed at schools as a resource for education. The use of school gardens as a teaching platform has wavered for over a century, motivated and hindered by the demands of society and the garden's perceived effectiveness in addressing these demands. The current demands on school gardens are to fill the gap in education on health and environmental sciences. Existing research on school gardens centers around the educational and health benefits of gardens, but information on the design of these interactive learning gardens is limited. This research investigates the design and layout of existing middle school gardens in two counties in Georgia to define a general framework for designing educational gardens. The guidelines and recommendations developed through this research are then applied to two conceptual school garden plans for Hilsman Middle School in Athens, GA and Druid Hills Middle School in Decatur, GA. The goal of this research is to provide foundational design parameters for organizations and individuals seeking to develop their own school garden.

INDEX WORDS: Edible Landscapes, Educational Landscapes, Garden Design, Landscape Architecture, Learning Landscapes, Outdoor Education, School Gardens

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DEDICATION

I would like to dedicate this thesis to Cassi Romero and my family. Without all your support and encouragement, I would not have achieved what I have today. You helped me push through the tough days and celebrated with me on the good days. I am so grateful to have all your support and love in my life.

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CHAPTER 1

Introduction

Every year, there are increased pressures on public middle school educators to cover more material and provide a deeper understanding of subjects. Teachers are burdened with meeting countless standards, often feeling the pressure to go beyond the baseline curriculum standards. Schools also face the pressure of being one of the most direct influencers on teaching health and life skills to students. With all these mounting responsibilities, many schools have turned to school gardens as tools to help meet the demands on public education. Two of the main driving issues behind the rise in school garden popularity are student health and environmental literacy. In the United States, the obesity rates in children are still high. According to the Center for Disease Control and Prevention one in five children between the ages of six and 19 are obese ("Healthy Schools"). Schools, and other programs, are fighting to help bring these rates down and teach children about being healthy. School gardens have proven to be a helpful tool to teach about nutrition and physical fitness, providing schools with a unique tool to improve the health of the youth in the United States. School gardens also provide an opportunity for students to learn about the environment and understand issues and pressures on the environment. In school gardens, students can learn about plants, animals, and insects, as well as start to understand the complex systems that exist within our world. With concerns about climate, weather, ecosystems, human environmental

impact, and technologies, the school garden provides a learning environment for students to see firsthand how the environment works.

Background

Gardens in schools have been utilized intermittently throughout the history of formal education. Cultures around the world have discovered and rediscovered the diverse means of teaching through gardens and nature. In the United States, there have been numerous movements of popularity in using school gardens for education. These movements often corresponded with social demands, such as the use of victory gardens at schools to supplement food sources during war times. School gardens have been used throughout history to engage students in the subjects they are learning, whether used as just a general tool in the earliest of education stages, a food source for schools or the community, or to help teach sciences in a more immersive way.

The reasons that school gardens continue to surface as a teaching tool lie in the heart of pedagogical theories and practices based on experiential learning. For decades, educators and theorists have studied pedagogy techniques. Experiential learning is a common education theory founded on the ideas and research of educational theorists like David Orr, John Dewey, and David Kolb. All three discuss the importance of experience, experimentation, and immersion, to not just teach, but to help improve retention of information. John Dewey discusses the idea that while both traditional education and progressive education can utilize experiences, the type of experience is more important. The experiences need to connect and build to further experiences (Dewey 1997). Dewey saw education as a continuity of experience; the experiences in education need to build

on past experiences and impact future experiences (Dewey 1997). David Orr's basis of education theory is that "all education is environmental education" because people are a part of the environment and depend on the environment for resources (Orr 2004, 12). In Orr's discussions on education he emphasizes that knowledge is built on understanding the effects of that knowledge, and argues that the method of learning is just as important as the content (Orr 2004). Orr details his thoughts on what is wrong with traditional education, and one of the biggest dangers he discusses is that traditional education can take away from the sense of wonder that drives people to learn (Orr 2004). David Kolb wrote the book *Experiential Learning: experience as the source of learning and development*; his concepts are formed through the research and theories of other education theorists like John Dewey, mixed with his own research and expertise (Kolb 1984). He states that "experiential learning offers something more substantial and enduring. It offers the foundation for an approach to education and learning as a lifelong process that is soundly based in intellectual traditions of social psychology, philosophy, and cognitive psychology" (Kolb 1984, 3). Kolb believed that "learning is the process whereby knowledge is created through the transformation of experience" (Kolb 1984, 38). In Kolb's model of experiential learning, he emphasizes the combination of concrete experiences, reflective observation, abstract conceptualization, and active experimentation to form knowledge.

Experiential learning means that learning is a continual process, not just an outcome, and that this process is best served by actual experience (Kolb 1984). It is this model and idea about learning that school gardens are best suited for, creating an environment in which students not only learn the concepts, but experience them and

approach the objectives with their own past experiences. This process of presenting knowledge in the garden, combining a new experience with an old, is what helps with retention, and is touted by Orr, Dewey, and Kolb as essential to the learning process (Dewey 2004, Kolb 1984, Orr 2004).

Current Research

With the increase in the use of school gardens and the pedagogical focus on experiential learning, school gardens have been a popular subject of research. Most research on school gardens looks at nutrition, health, and diet, or ecological education. With the rising concerns for the health of youth in the United States, it has become a priority in education to improve health and nutrition education. Existing research completed on school gardens documents student health, with numerous positive results. Studies have shown increases in consumption of fruits and vegetables, increases in mild exercise, and improved mental health (Allen et al. 2008, Evans et al. 2016, Grant and Littlejohn 2001, Hirschi 2015, Ratcliffe et al. 2011). These studies have helped to foster the continued growth and support of school gardens as an educational tool.

Additional research has been completed on utilizing school gardens to improve environmental education, teaching children about agriculture and the natural environment (Blair 2009, Burns and Miller 2012, Food et al. 2005, Grant and Littlejohn 2001, Lawson 2005, Scherr et al. 2013). Using gardens in environmental education helps to reconnect children with the environment, teaching them about where food comes from, ecosystems that plants and animals depend on, and, most importantly, how humans impact those ecosystems. Many researchers theorize that this knowledge will lead to a more

environmentally conscious generation, with the hope that they can help improve the state of the natural world (Blair 2009, Burns and Miller 2012, Grant and Littlejohn 2001, Lawson 2005, Orr 2004).

To date, much of the research on school gardens has focused on the uses, benefits, and pitfalls of gardens for education, but little research exists on designing gardens, not just for education, but for the school environment. Much of the existing research proclaims the numerous benefits of gardens, but without proper design and planning before implementing a garden on a school site, even with all the benefits, the garden may fail. Not only for initial success, but for their sustained success, school gardens need to be planned and designed as thoughtfully as school buildings and classrooms.

Research Objectives and Justification

Currently, there is a gap in knowledge about designing gardens at schools for educational use. The intent of this research is to discover and develop optimal guidelines on the layout and design of educational gardens for schools. With the increasing demands to implement school gardens at multiple levels and sizes, definition is needed to make sure adequate consideration is given to important elements in the garden. The guidelines and recommendations laid out in this research could be utilized by administrators, teachers, individuals, professionals, and organizations as a foundation for their own educational garden planning. Currently, what little data related to school garden design that exists is really just focused on general outdoor education and outdoor classrooms, not interactive gardens on school campuses. The body of existing research shows the value of garden-based education techniques to teach numerous subjects and

disciplines, presenting information in an easy to understand platform. This research aims to provide general guidance and considerations for school garden planning, which should be applicable at most sizes and levels of implementation. The objectives of this research were to answer these questions:

- How can school gardens be designed to best facilitate the educational experience?
    - What are the essential physical elements necessary for a school garden to function?
    - What are some of the regular program demands for a school garden?
    - What are common issues or concerns in the layout of a school garden?

Methodology

In the effort to answer these questions, this research examines existing garden design theories and case studies of existing middle school gardens in Clarke County, Georgia, and Dekalb County, Georgia.

Theory Exploration

Though there is limited existing literature on designing for school gardens, there is existing research on other garden design typologies. A framework for recommendations on school gardens can be developed through the classification and evaluation of other existing design guidelines. This research will investigate small scale home garden design, community garden design, and permaculture garden design. Home

gardens are often designed to be easily maintained and simply accessed by one or two individuals. Community gardens are designed for a diversity of people in varying age groups, with the flexibility of being implemented at a variety of scales. These gardens emphasize ease of access and maintenance. Permaculture landscapes are designed to create a system of plantings that can often work together to be self-sustaining. The layout of permaculture gardens focuses on the convenience of use, with more frequently used systems located closest to the residence. The basis of all three garden types can be analyzed, modified, and combined to give a foundation for general ease of use of gardens, with modifications focused on the use by children and classes under the direction of one or two instructors.

Case Studies

Case studies of six sites were developed through site analysis and teacher questionnaires. The study was conducted in Georgia at two middle school gardens in the Clarke County School District, and four middle school gardens in the Dekalb County School District. All study locations were observed, and all the existing features of the school gardens were inventoried and mapped. These maps provide multiple footprints for school garden layout analysis. Questionnaires were prepared and distributed to teachers at each study location to evaluate the use of the school gardens and determine barriers or issues with using the school garden. The purpose of these questionnaires was to provide a baseline of what is being taught in the gardens, and physical features of the garden that either help or hinder learning. The answers provided in the questionnaires

were analyzed to determine additional recommendations in school garden design with insight from educators that actually use school gardens.

Application

Once the guidelines and recommendations were defined by the research, a conceptual design was developed for Hilsman Middle School in Athens, Georgia, and Druid Hills Middle School in Decatur, GA. Hilsman Middle School previously had a garden, but with current construction, it has been destroyed, and the school will need new gardens to be incorporated into the reconstructed school grounds. Druid Hills Middle School has an existing school garden area but has expressed the desire to expand and redesign the small garden space. The purpose of the application was to implement and test the ability to apply the guidelines developed in this research to actual school garden designs.

Limitations and Delimitations

The sites for research were limited due to construction on school sites, as well as district permission for research. This research is only a small sampling of educational gardens being utilized by schools located in two counties in Georgia. Due to the limited sample size, the results of this study will not be universally applicable to all school gardens. Additional research will be needed on other school garden typologies, such as dense urban schools with little to no available outdoor space. The conceptual design developed using the guideline research will be specific to the test sites' conditions and constraints. This research does not account for student views on school garden layout

and design; any student concerns are communicated through the instructors' questionnaires, and not directly through students.

Thesis Structure

This thesis includes eight chapters.

- Chapter 1, this chapter, is an introduction to this study.
- Chapter 2 provides general background information on school gardens and outdoor learning. It is a review of literature on school garden history, curriculums utilized in school gardens, and the impacts of outdoor learning.
- Chapter 3 defines the setting for the research, the location of the study sites, and general information on the schools. This information will provide context for the case study information collected.
- Chapter 4 discusses the case study research, including the methods and analysis of the information collected during the case study work.
- Chapter 5 details the exploration of existing garden design theories and the conclusions drawn for applying the existing garden design techniques to the school garden setting.
- Chapter 6 details the guidelines and recommendations developed through the research.
- Chapter 7 is the application of the guidelines defined in Chapter 6 to Hilsman Middle School and Druid Hills Middle School. The applications include conceptual design plans with a discussion on how the guidelines were utilized to develop the designs.

- Chapter 8 concludes the research, discussing future possibilities for additional research.

CHAPTER 2

Background

History of School Gardens

Gardens for education and outdoor learning are not a new idea and they have been utilized in education for centuries. Early records of gardens being implemented in formal education date back to the 1800's (Gardner Burt 2016, Hirschi 2015). In the mid-19th century, Frederick Froebel started using the word kindergarten which translates to "children's garden" because gardens were utilized as a foundational education tool (Gardner Burt 2016, Hirschi 2015, Lawson 2005). Gardens for education were common throughout Europe in the 19th century; some countries even required that schools have gardens for learning. In the United States, the first official school garden was built in the 1890s at George Putnam School in Roxbury, Massachusetts (Gardner Burt 2016). Within a few years, the first 4-H program was started by Albert Belmont Graham, based on the education principles utilized for the George Putnam School garden (Gardner Burt 2016). At this same time, Francis Griscom Parsons developed the Children's School Farm (now DeWitt Clinton Park) in New York City, for educating children in the city schools about nature and agriculture (Gardner Burt 2016).

The pedagogical impact of the school garden movement surged in the early 20th century thanks to the influence of educators and theorists that favored the ideas of progressive education. The writings of John Dewey formed the backbone of the ideas of the progressive education movement and championed the concepts that lessons in the

school should translate into life skills and the curriculum should be influenced by the place of learning (Dewey 2004, Hirschi 2015). Maria Montessori also embraced learning in the garden because it fit into her philosophy of education through exploration, observation, and experience. Under Montessori's teaching students learned through their peers, with choices guided by their teachers, and by manipulating not only their environment but their existing knowledge (Gardner Burt 2016, Hirschi 2015, Lawson 2005). The educators behind the progressive education movement believed that education was about discovery and exploration, and gardens are well suited for this practice.

It was during World War I that school gardens became a staple of schools in the United States. During World War I, the government encouraged schools to plant vegetable gardens to produce food for the troops fighting in the war (Gardner Burt 2016, Kohlstedt 2008, Lawson 2005). These wartime gardens, often referred to as victory gardens, became indispensable in school yards across the country as a way for children and communities to participate in the war efforts. After World War I, school gardens declined, then resurged during World War II, and then declined again after World War II in favor of more structured and regulated curriculum standards (Gardner Burt 2016, Kohlstedt 2008, Lawson 2005). Due to efforts to create equal educational opportunities, government curriculum standards shied away from interpretive teaching curriculums in favor of new, measurable teaching criteria, which are still being used today (Gardner Burt 2016). It is at this time that school gardens decline in use with only a few school gardens developed, mostly by small individual efforts. Subsequently, starting at the very end of

the 1970s, amid a movement against industrial farming, school gardens regained some attention (Gardner Burt 2016, Lawson 2005).

During the 1980s, 90s, and even into the early 2000s, school gardens grappled to find a strong foothold as a fundamental educational tool. Even with support, gardens struggled to get off the ground in school curriculums. In recent years school gardens became popularized through the efforts of Michelle Obama and her Let's Move campaign (Gardner Burt 2016). The Let's Move campaign consists of five initiatives which include providing healthy food in schools, improved access to healthy, affordable food, and increased physical activity, all elements that participation in school gardens encourage. When considering the history of school gardens and gardens as educational tools, it is apparent that movements to utilize gardens in education fluctuated depending on the needs or demands of society at various times. Gardens have been popular in times of war, valued when the benefits are tangible, or encouraged to facilitate connection to agriculture and nature. Once again, school gardens are responding to societal demands in the United States, demands to improve childhood health, and to increase agricultural and environmental awareness.

Curriculums in School Gardens

Garden-based learning is an alternative way of teaching and can be incorporated into numerous curriculum subjects. Nutrition education is currently the most prevalent use of school gardens in the United States, teaching students about food and dietary health through growing edible plants (Food et al. 2005, Grant and Littlejohn 2001, Hirschi 2015, Johnson, Duffek, and Richards 2008). With childhood obesity being a

prominent issue in the United States, schools have implemented programs that improve the nutrition standards of the meals provided on campuses, many using farm to school programs to implement these changes. School gardens take the farm-to-school concept one step further in connecting children with nutritious food choices (Bontrager Yoder et al. 2014). Children learning in school gardens can create a connection with and lifelong knowledge of fruits, vegetables, agriculture, and how food systems work.

The second most common use for school gardens is to teach environmental education (Bucher 2017, Food et al. 2005, Grant and Littlejohn 2001, Hirschi 2015, Johnson, Duffek, and Richards 2008). Instead of learning about the environment in the classroom, teachers are going outside, so students can experience certain concepts firsthand. Educational landscapes are not limited to just food and environmental education, a multitude of subjects can be taught outside using the garden. Research reveals that school gardens have been used for various sciences, mathematics, art, language arts, social studies, history, culture, and life skills curriculums (Food et al. 2005, Grant and Littlejohn 2001, Hirschi 2015, Johnson, Duffek, and Richards 2008). The multidimensional use of gardens as a teaching tool means that learning in the context of a garden can be broad in scope, taking many structured curriculum subjects and providing new ways to teach the material. Learning in school gardens shares many of the same benefits and techniques as other outdoor learning experiences.

Outdoor Learning

The benefits of outdoor learning environments have been extensively researched. Researchers have found that outdoor learning can be more engaging to students than learning in a standard classroom setting because it stimulates all the senses and allows interaction with subject material (Burns and Miller 2012, Grant and Littlejohn 2001, Hirschi 2015, Johnson, Duffek, and Richards 2008). Some of the prominent examples of outdoor learning allowing stimulation and interaction include learning about weather, photosynthesis, the water cycle, and food production. The key to outdoor learning is that it is an experiential learning process. Experiential learning provides a platform for students to learn from their own experiences, observations, interaction, exploration, and the engagement of multiple senses (Kolb 1984). The processes of experiential learning and the way that it influences learning and retention is based off pedagogical theories of David Orr, John Dewey, and David Kolb.

The model of experiential learning developed by David Kolb investigates learning through an experience, the experience can then cause reflection, and can be connected to an abstract concept, which allows for understanding (Kolb 1984). This approach to learning absorbs students in active problem solving and develops whole system thinking concepts (Burns and Miller 2012, Dewey 2004, Grant and Littlejohn 2001, Kolb 1984, Orr 2004). It allows a student, through their own interactions, to be able to break down the components and processes of a complex system, like the water cycle, allowing for a less abstracted understanding of the subject and connecting it to the real world outside the classroom.

Not only are outdoor learning environments associated with an improved understanding of subjects, but they can influence social and personal development (Burns and Miller 2012, Food et al. 2005, Grant and Littlejohn 2001, Hirschi 2015). Outdoor classrooms require students to participate in social engagement, can create a sense of community, and foster personal pride and self-esteem (Food et al. 2005, Grant and Littlejohn 2001, Hirschi 2015). Students must participate and communicate with other students when working in the garden facilitating the development of social skills. A child working in a garden starts to develop a sense of involvement and ownership of his or her school and community and children may learn that they are a part of a larger system of community themselves. Lastly, the sense of ownership that a garden can provide helps to foster self-confidence and pride. Furthermore, since outdoor learning is a more interpretive learning method, it can span various learning styles, helping students that struggle in the traditional classroom setting to enhance understanding of the subject material (Grant and Littlejohn 2001, Hirschi 2015). Research has shown that outdoor learning environments also foster multidisciplinary learning, increase understanding of complex systems, and help teach about the connections of the world (Burns and Miller 2012, Grant and Littlejohn 2001, Hirschi 2015, Johnson, Duffek, and Richards 2008). A garden is not just one thing, not just one subject; it provides a real-world application for a variety of topics and helps to communicate the connections between those topics.

Though outdoor learning and school gardens have a long list of benefits, they also have limitations. Some of the biggest barriers to school garden success are lack of time, insufficient resources to manage gardens, general site challenges, disconnect from the curriculum, and vandalism (Grant and Littlejohn 2001, Hirschi 2015). Programs

planning to integrate gardens must take these limitations into consideration if they desire the gardens to be incorporated into the school curriculum long term.

CHAPTER 3

Study Setting

The research for this study is focused on school gardens being utilized in middle schools within two areas of Georgia, Clarke and Dekalb counties. There are numerous factors that influenced the selection of middle school gardens for study sites. One of the factors in selecting middle school level gardens is the amount of involvement the students can have in the garden. Compared to elementary age students, middle school students are older and more capable of participating in more complex garden activities. Middle schools also seem to be a popular level of education to utilize gardens; most school gardens in the Atlanta and Athens region of Georgia are in elementary schools and middle schools, with very few being utilized by high schools. The curriculum for middle schools in Georgia includes a variety of topics that can be taught in the garden, like photosynthesis and other natural cycles, literature, poetry, geometry, and even art. Lastly, middle school aged students are at a pivotal age of development, moving from childhood to the early stages of adolescence. This period of development is marked by children wanting to take more responsibility and be more independent (Morin 2014, Tai 2006). School gardens can offer opportunities to fill these developmental needs.

When selecting the school sites for this research, the intention was to have a variety of school sizes in both an urban setting and a small-town setting. To complete studies in public schools, the researcher must obtain permission from the district. Permission was granted to study schools in the Clarke County School District and the

Dekalb County School District. The final sites were chosen because they had established school gardens, granted permission for the study, and had no construction impeding the research. The only site that is under construction is Hilsman Middle School in Athens, GA, which was selected due to the opportunity to help design a new school garden for the site after reconstruction. The following sections include some background information about each study site. Figures 1 and 2 are maps of the counties that are marked with the location of the school study sites.

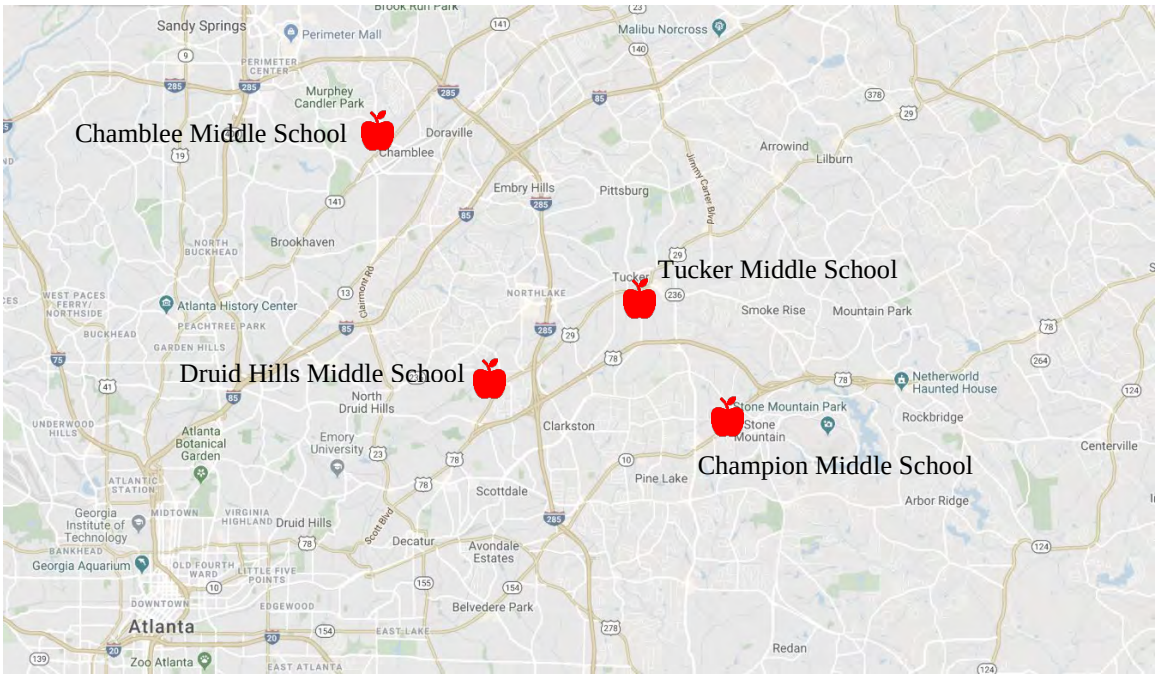


Figure 1. Dekalb County School District Study Sites
Map from Google Maps, Dekalb County Georgia

Dekalb County School District

Chamblee Middle School

3601 Sexton Woods Drive, Atlanta, GA

School established at current location: 2008

School average enrollment: 975 students

The school garden at Chamblee Middle School was started in 2011 to teach biodynamic gardening techniques to students. The garden was established due to the efforts of an individual teacher and a group of parents. Initial funding for the garden was acquired through grants from Seeds of Change and Captain Planet. Funding to maintain the gardens comes from the school's PTA and through school funds requests. The garden is managed by Mary Moore, one of the science teachers at Chamblee Middle School, and maintenance of the garden averages about six hours a week during the growing season and about one hour a week in the winter months. Beyond the gardens being used in lessons, the garden is also utilized by the school's Ecology Club (Moore 2018).

Champion Middle School
5265 Mimosa Drive, Stone Mountain, GA
School established at current location: 2006
School average enrollment: 750

The school garden at Champion Middle School was established in 2011. The garden was started as a service-learning project for students. The garden has been funded by various grants, community donations, and school fundraisers. The Science Club and the STEM Team maintain the garden, averaging about three to four hours a week maintaining the beds. The garden is used by the Science Club, STEM Team, and an after-school garden club. Produce is donated to the Stone Mountain food pantry and the Atlanta food pantry (Mack 2018).

Druid Hills Middle School
3100 Mountain Olive Drive, Decatur, GA
School established at current location: 1996 (name change in 2011)
School average enrollment: 950

The school garden at Druid Hills was established over ten years ago by the school's Environmental Club. Funding for the garden comes from grants, donations, and fundraising done by the Environmental Club. The garden is also maintained by the Environmental Club and teacher Kathy Cochran, who work on average 10-15 hours a month maintaining the gardens. Though the garden is managed by the Environmental Club, it is open to use by all classes and is popular among the science classes and a few of the English Language Arts classes on campus (Cochran 2018).

Tucker Middle School
2160 Idlewood Road, Tucker, GA
School established at current location: 2004
School average enrollment: 1250

The garden at Tucker Middle School was started in 2014 to enhance the learning experience for students at the school. Funding for the establishment of the garden and maintenance is mostly from grants, but some additional funding comes from student fees. Science teacher Dr. Stephen Csukas manages the garden and assists in teacher involvement in the garden. On average, the garden requires maintenance three to four hours per week. Outside of classes, the school has put together a small market with produce grown in the garden. Occasionally, the small school market joins the local farmers market on Main Street in Tucker, GA (Csukas 2018).

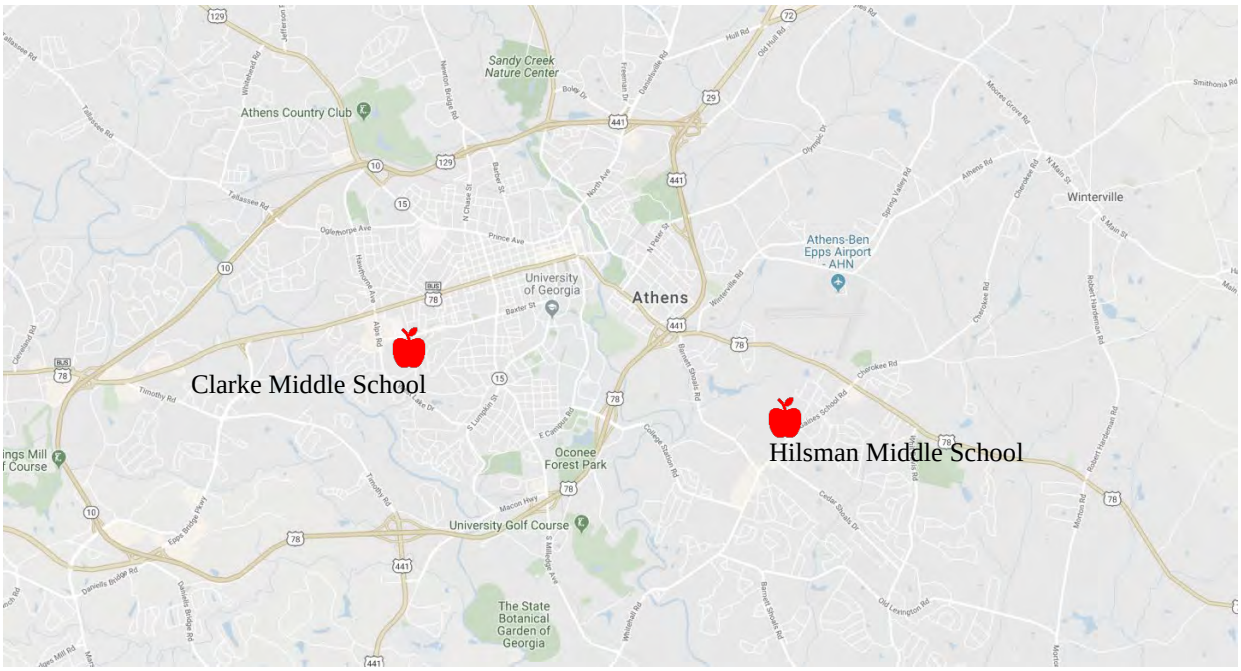


Figure 2. Clarke County School District Study Sites
Map from Google Maps, Clarke County Georgia

Clarke County School District

Clarke Middle School

1235 Baxter Street, Athens, GA

School established at current location: 1959

School average enrollment: 780

The gardens at Clarke Middle School were started in 2011 to promote sustainability education and for use in the agriculture education classes and the food and consumer science courses. The initial set up and funding for the garden came through the University of Georgia, community support, and AmeriCorps Vista volunteers. The garden is maintained by the agriculture education class, with teacher Courtney Bolden and the current AmeriCorps Vista worker Tessa Wilson. The gardens are used for numerous camps, like the Summer Kitchen Corp camp, and several clubs like FFA and the Sustainability Club (MacMillan 2018).

Hilsman Middle School

870 Gaines School Road, Athens, GA

School average enrollment: 750

Hilsman Middle School is currently under construction to build a new school building. The old school gardens have been demolished due to the new building construction. Research from this site is based on the old school garden layout and use prior to construction activities. The conceptual school garden design for the site presented in Chapter 7 is based on the new school building plans. The previous school gardens for Hilsman Middle School were started in 2016, though the school had some raised beds before 2016. The gardens were started for agriculture education and to promote fresh, healthy food education and access. Funding and support for the gardens have come from numerous grants, the Office of Applied Learning, University of Georgia, and the Grow it Know it program personnel. The gardens were mostly managed by the agriculture classes, the AmeriCorps Vista workers, and the Grow it Know it program. Maintenance in the garden ranged from a three hours per week up to 15 hours during the peak growing season. The gardens were also used for tours and camps outside of classes (Martin 2019).

CHAPTER 4

Case Studies

Case studies were completed on the six school gardens described in Chapter 3. These case studies provide baseline information on existing, operational school gardens. This allows for comparison and analysis to be made based on the existing garden models. The case study investigation also sought to provide insight on the gardens from the educational professionals that use the gardens. The case study research consisted of two parts: a site inventory to document the layout of the existing gardens and a questionnaire for school faculty to provide feedback on the use of them. The site inventories were used to measure and document the existing garden spaces for each school and compare garden design practices among schools. The questionnaires were distributed digitally to allow faculty users of the garden the opportunity to share their own personal insights on the layout of the garden spaces, (see Appendices A and B). The sections below detail the case study research and findings.

Site Inventories

Each subject site was visited at least once during the case study research period. During the site visits, details of the garden were mapped and documented. This documentation included photographs of the site (see Appendix C), measuring and mapping all the components of the site, and noting the function of all the garden elements, like annual crop beds. Some of the observations noted during the site inventory

included: dimensions and layout of paths, beds, structures, and other components of the garden; the location of water sources; proximity of building access; and notation of site conditions like sun, wind, and topography. The site inventories were conducted to compare and analyze the layout of existing gardens to define common features and design techniques already being implemented in school gardens. A more detailed description of the components and functions of each school garden is listed in the subsections that follow.

Site Descriptions

Chamblee Middle School

The learning garden area at Chamblee Middle School is centered in a protected area behind the school next to the cafeteria (see Figure 3). The garden is predominately used by the school's science classes. The site is bordered on two sides by steep wooded slopes; the other two sides are protected by wings of the school building. There are three large raised beds for annual vegetable crops, with one bed designated per grade level. The six trough beds are an herb garden with both annual and perennial herbs. The three square raised beds have been used for biodynamic gardening. The site includes a storage shed for tools and materials storage, birdfeeders and a bird bath, ornamental trees, and a weather station sensor. The planting bed to the north of the garden is planted as a pollinator garden. There is a large patio on the west edge of the garden with a brick seat wall and several picnic tables. Currently, the only water source is provided by a hose running from the utility area. Most of the site is turf, with the space around the herb garden beds layered with gravel.

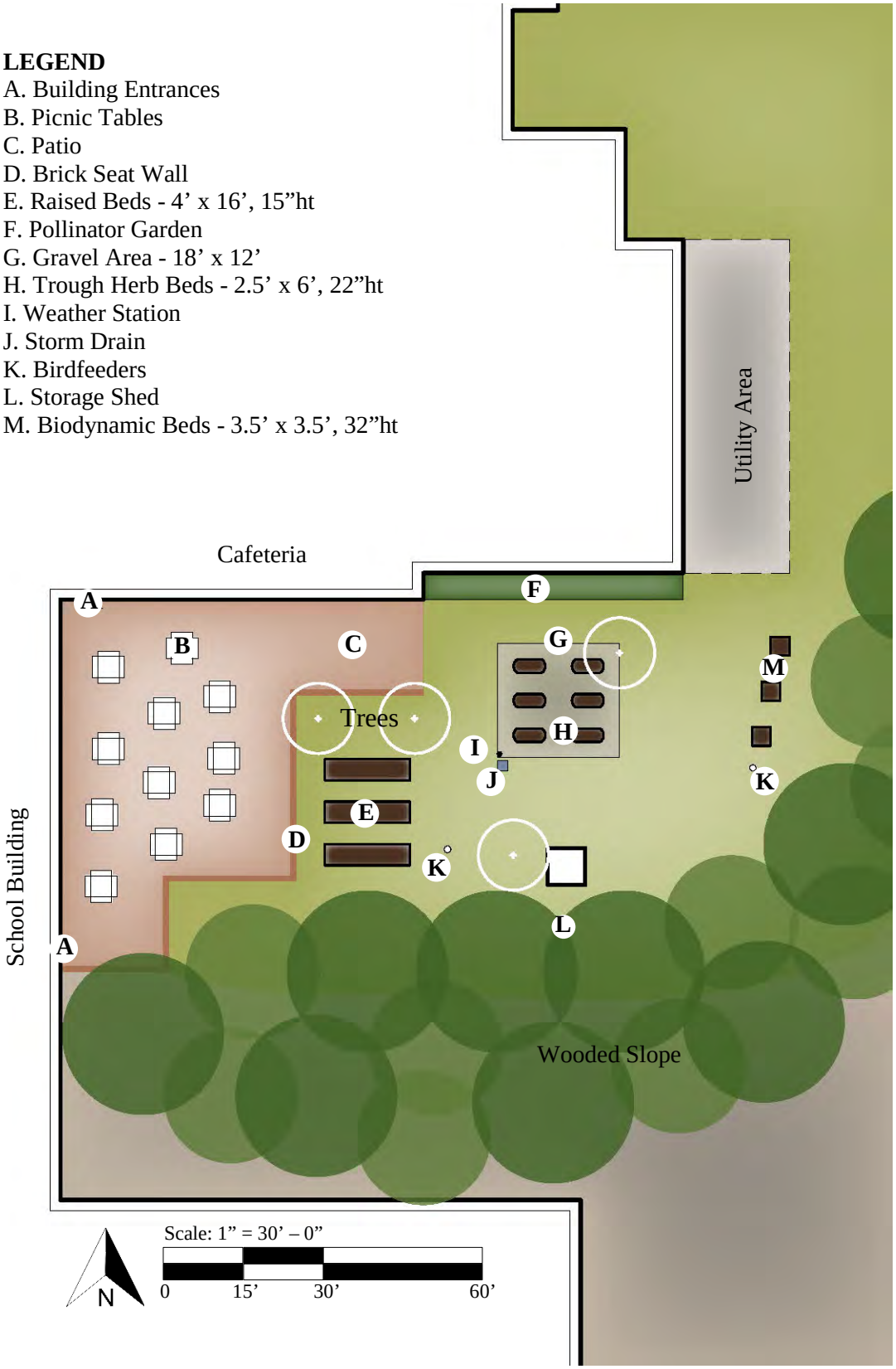


Figure 3. Chamblee Middle School Garden Layout

Champion Middle School

The learning garden space at Champion Middle School is behind the school, just outside the main hallway. The gardens are used by the science classes to support the school's STEM program. The garden space is open and sunny but protected by the wings of the school building (see Figure 4). The eight rectangular raised beds are the main garden beds; these are used for annual crops, herb gardens, and a pollinator garden. The eight square beds to the southwest are not currently being used. The large beds along the wall of the school building are planted in wood pallets to create a type of low raised bed, with one pallet set up vertically to create a vertical garden. These pallet beds are used for annual crops. The site has one storage shed for tools and supplies and a three-bin compost system. The site is relatively flat, with a gentle slope descending towards the two storm drains. Many of the raised beds have irrigation, but the site also has one hose connection for supplemental watering. There are picnic tables scattered throughout the site for seating and work spaces. The material surrounding all the beds is turf. The site also includes two birdfeeders and a large sign kiosk.

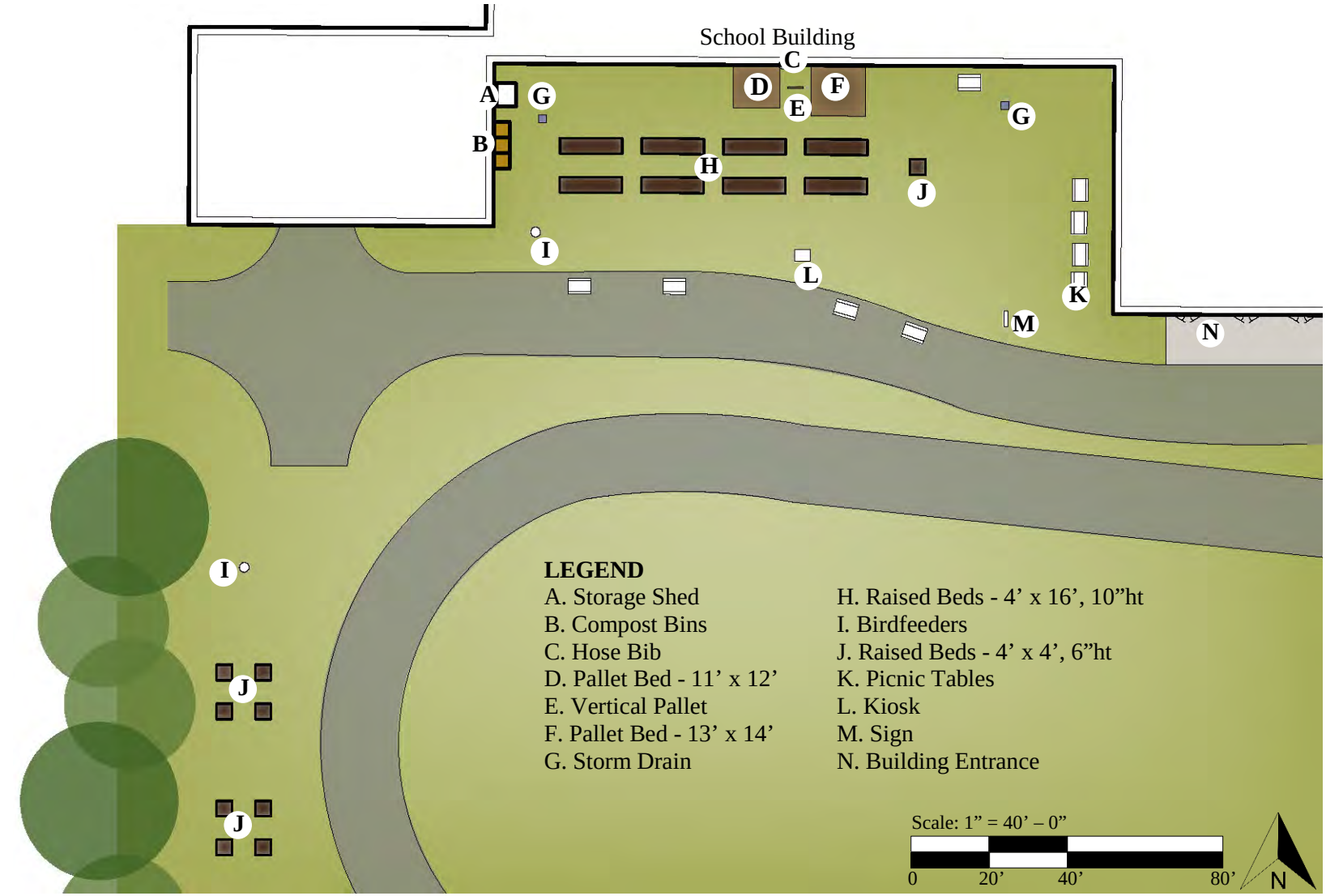


Figure 4. Champion Middle School Garden Layout

Druid Hills Middle School

The learning garden area at Druid Hills is tucked between two wings of the school near the parking lot and loading dock area (see Figure 5). The site has ten raised beds of variable sizes, all showing signs of deterioration, with the wood structure of the beds warping and decaying. There are two large pollinator garden beds along the south end of the garden. The area has two small sheds and one small storage trunk to store materials and supplies. The garden has one large barrel compost bin and has six rain barrels connected to downspouts for watering. There is also a hose connection on the building for a supplemental water source. Existing sidewalks run through the garden space, and four picnic tables sit to the west side of the site. The garden faces problems with damage from the loading dock area due to vehicles driving over the curbs, and harsh microclimate areas where the classroom HVAC units blow out hot dry air over the beds.

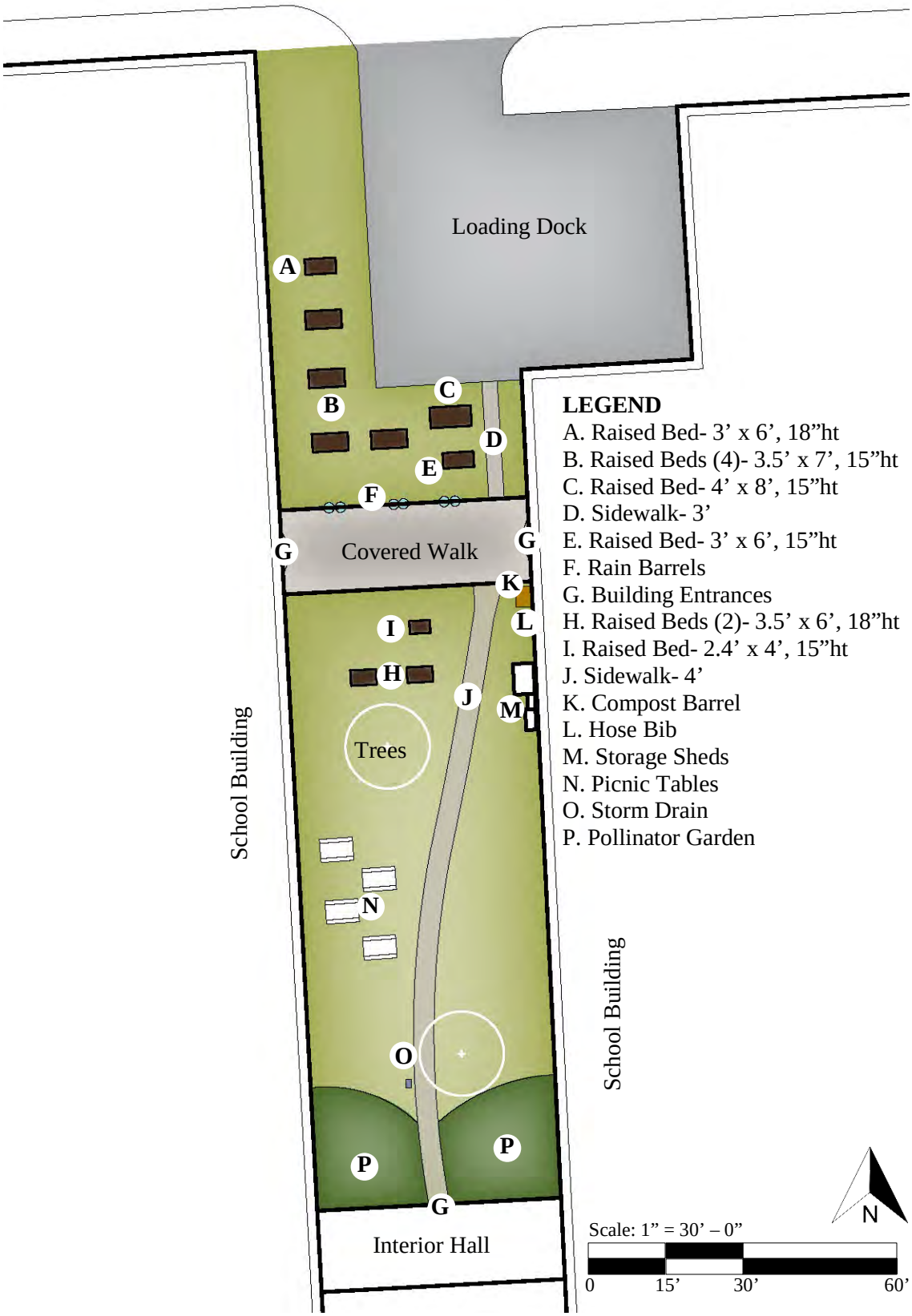


Figure 5. Druid Hills Middle School Garden Layout

Tucker Middle School

Figure 6 details the existing layout of the school garden space at Tucker Middle School. The school garden at Tucker Middle School is composed of eight large raised beds and four small raised beds. This garden also features an aquaponics table and a new greenhouse. The school has recently added a three-bin compost area. The site is centrally located by the school cafeteria and is surrounded on three sides by wings of the school. The site is mostly shaded, due to a large number of shade trees planted around the area. This shade has started to limit the crops that the school can grow. The site has a slight slope to the large storm drain and can have standing water after large rain events. For seating, there are two benches at the edge of the garden and several large picnic tables in the patio area. The area has two locations for hose connection and a power outlet that runs the pump system for the aquaponics table. The school is in the process of installing security cameras to combat theft issues. Most of the site surface is soil or turf, with the areas surrounding the raised beds covered with gravel. There are also a three ornamental plant beds on the site. A small shed on the patio area houses tools and supplies for the garden.

LEGEND

A. Compost Bins
B. Hose Bibs
C. Electrical Outlet
D. Raised Bed - 4’ x 8’, 8”ht
E. Aquaponics Table
F. Ornamental Plantings
G. Gravel Area - 20’ x 47’
H. Raised Beds (9) - 4’ x 10.5’, 8”ht
I. Greenhouse
J. Building Entrances
K. Storage Shed
L. Picnic Tables
M. Seat Wall
N. Patio
O. Benches
P. Raised Beds (4) - 4’ x 4’, 8”ht
Q. Gravel Area - 20’ x 27’
R. Storm Drain

Figure 6. Tucker Middle School Garden Layout

Clarke Middle School

The gardens at Clarke Middle School operate as a small farm; they include numerous areas of raised beds, large row crop beds, and animal enclosures (see Figure 7). The section of the gardens at the front of the school includes rotational row crop beds enclosed with fencing, herb garden beds, a small orchard, a small storage shed, a multi-bin compost area, and a large pen for goats. The remainder of the garden spaces are incorporated between wings of the school and are all secured by fencing. The northern most section includes three small raised beds, a large greenhouse, a cistern, a storage shed, two washing stations, a large area for chickens, and a small pollinator garden. The next section to the south includes eight raised beds surrounded by paving to allow wheelchair access. This area also has picnic tables and an outdoor classroom area. The southernmost section of the gardens is actually managed by Athens's Master Gardener group, which grows food to donate to local shelters. The Master Gardener garden has numerous raised beds, grape vines, shrubs, and some ornamental plantings, but is not used by the school for classes.

LEGEND

A. Herb Garden Beds
B. Fencing
C. Rotational Row Crop Plots - 20' x 50' each
D. Edible Shrub Bed
E. Orchard
F. Secured Gates
G. Storage Sheds
H. Hanging Garden
I. Building Entrances
J. Raised Beds (3) - 4' x 8', 12"ht
K. Greenhouse
L. Compost Bins
M. Pollinator Garden
N. Covered Walkways
O. Sidewalk- 6'
P. Outdoor Classroom Area
Q. Sidewalk- 3'
R. Picnic Tables
S. Raised Beds (8) - 4' x 8', 4-18"ht
T. Ornamental Plantings
U. Pavers
V. Master Gardener Food Garden

Figure 7. Clarke Middle School Garden Layout

Hilsman Middle School

Hilsman Middle School is currently under construction. The old building is being replaced and the old gardens have been demolished in the process. This site analysis is based on the old school garden site prior to demolition (see Figure 8 for a plan of the old school garden site). The gardens at Hilsman were located in the back corner of the school site behind the portable classrooms. The garden had a goat pen, rotational row crop beds, four raised beds, an orchard, grape vines, berry shrubs, and a compost bin system. The area was open and sunny with no significant slope. The site included two water spigots, a large wash station, a single picnic table, and a storage shed. The site had two greenhouses, one large one and a second smaller one. There were also a few small raised beds scattered along the west side of the school, near the building entrances that are not included in Figure 8.

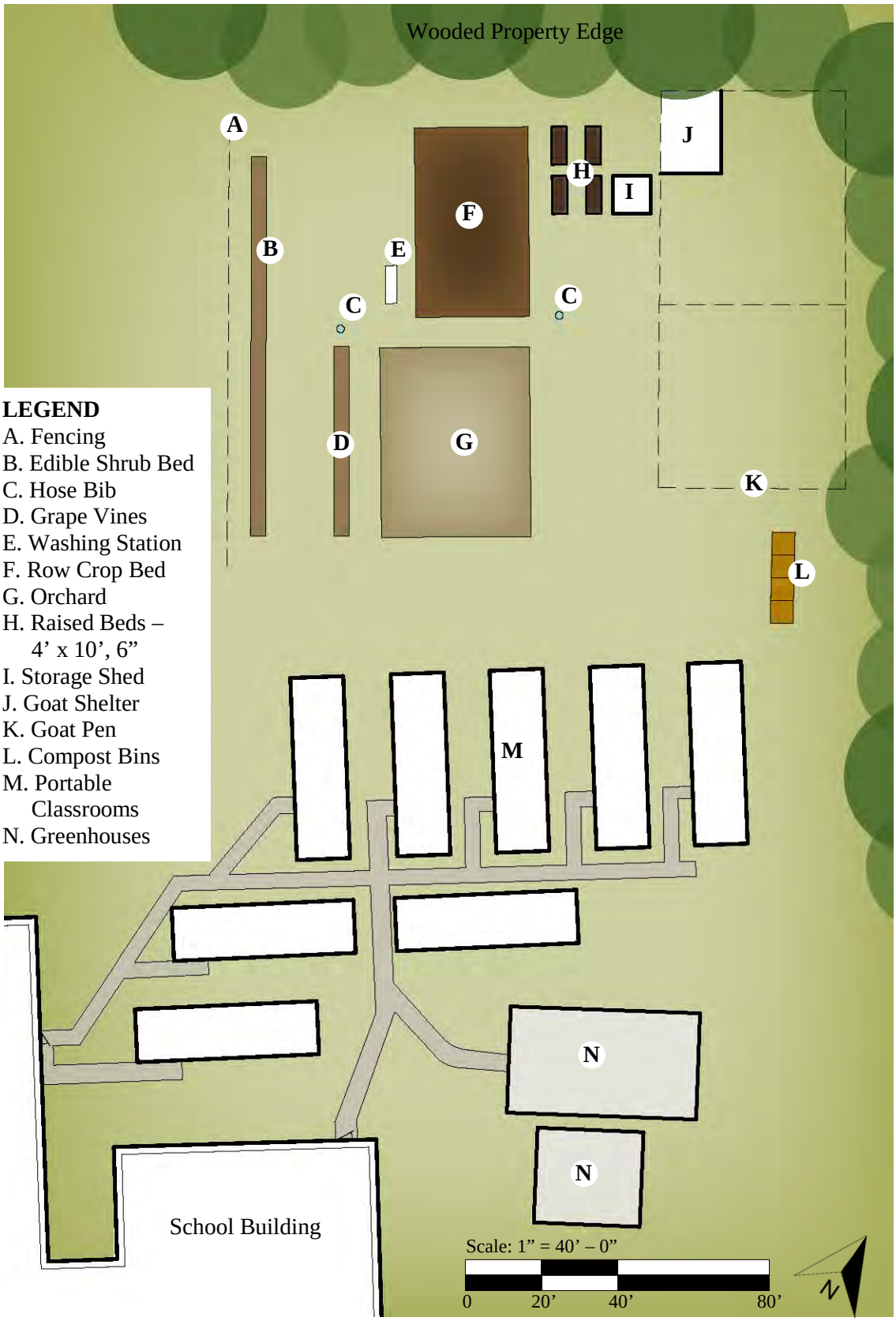


Figure 8. Hilsman Middle School Garden Layout

Analysis of Site Inventories

In documenting the layout of these six operational school gardens, it is possible to compare the designs to determine commonalities. These comparisons provide insight on common school garden design practices already in use and help illuminate gaps in the design needs of the garden spaces. Subsequent analysis can highlight some unique design practices to meet the needs of school gardens. The following subsections discuss the observed commonalities and design practices discovered through the site inventories.

Location

Most of the garden sites are located in centralized areas of the campus between wings of the school buildings. The gardens at Chamblee, Champion, and Tucker are all centered at the back of the school. Clarke Middle School has garden spaces between all four wings of the school buildings, dispersing the learning spaces. The garden at Druid Hills is located between two wings of the school buildings, but is more to one side of the campus, limiting access by classes on the other end of the campus. All of these gardens were located between 10-60 feet from a building entrance. Hilsman Middle School is the only garden that was located further away from the school building, about 150 feet from the nearest building entrance. The gardens at Hilsman were tucked into the back corner of its campus, next to the athletic fields and behind the portable classrooms. Through these observations, it is apparent that most of the schools tried to locate the garden spaces in areas easily accessible to all classes to use for teaching, as centralized and close to the school buildings as possible.

Water

All the gardens have access to hose connections for watering purposes. Some of the beds at Champion Middle School and Clarke Middle School are fitted with drip irrigation. Druid Hills Middle School has incorporated rain barrels connected to the building for supplemental water. Clarke Middle School is the only site that included a cistern to collect and store water for use in the school gardens. Water is an essential resource for gardens, and all the sites to have reliable water sources. Two of the schools have also developed ways to harvest and use rain water to meet the watering demands of their gardens.

Seating

Almost every garden space includes areas for students to sit or gather. The gardens at Chamblee and Tucker are both adjacent to outdoor dining areas. These spaces are equipped with several picnic tables that students and classes can utilize. Champion Middle School also includes a large number of picnic tables around the garden site. Druid Hills only has four picnic tables available in the garden. Clarke Middle has five picnic tables in one of the garden areas, and two picnic tables next to the greenhouse. The Hilsman Middle School site had only one picnic table available for seating. Tucker Middle School in addition to tables has two wooden benches at the edge of the garden space to provide additional seating to students and faculty. Clarke Middle School is the only site with an outdoor classroom, which includes two benches and some tiered wooden seating set in a circle for instructors to use. Areas for students to gather and sit for lessons and work surfaces for students to use appear to be a common feature in school garden spaces.

Beds

Every school garden site included raised growing beds. All the raised beds are either square or rectangular in shape. Most of the raised beds are around four feet wide, with the length varying from four feet to 16 feet. The only rotational in-ground beds were at the two Clarke County school sites. Raised beds are built of wood, composite wood, or concrete blocks. Chamblee Middle School also utilized tall, metal, livestock watering troughs for the herb garden beds.

Paths

Surfaces surrounding the beds on most sites is turf. Some of the gardens, like Tucker and Chamblee, include gravel areas around some of the raised beds. The width of the access aisles around the beds ranged from as small as 16 inches to as wide as nine feet, but most commonly, the aisles are between three feet and six feet in width.

Structures

All the garden sites included storage structures to house tools and other supplies for the gardens. Most of the garden sites also have some sort of compost area to use for garden waste. Half of the garden sites included greenhouses for the gardens.

Specialty Areas

Four of the garden sites included pollinator gardens. One of the sites offered an aquaponics growing system for the students to use. The Clarke County sites are the only ones that incorporated small orchards and animals into the garden spaces. All of these are additional garden learning spaces that broaden the topics that can be taught in the garden.

Accessibility

Only Clarke Middle School has beds that are fully wheelchair accessible, with paving around the beds to allow wheelchair access. Turf and gravel are not considered wheelchair accessible according to the American Disability Act unless they are within grid or paving systems. Both Clarke and Druid Hills gardens include beds designated for special education course use. Overall accessibility does not seem to be addressed for the learning garden spaces.

Site Inventory Conclusions

After the review of the six different sites and analyzing the layouts to determine commonly used design principles, it is clear that there are several principles already in use for school garden design. This includes locating the garden spaces in centralized areas close to building access. The gardens all made sure to incorporate a reliable water source. Seating was often provided in the garden, this included seating for leisure and workspaces for garden lessons. Raised beds were frequently used in the school garden study sites, these beds were often square or rectangular with a width of four feet or less. Paths and bed access aisles on average were three to six feet in width to accommodate students, tools, and supplies. Every garden had a storage structure to keep tools and many had compost areas for garden waste. If room permitted on the school site greenhouses were also incorporated into the garden to extend garden learning. Some of the gardens incorporated specialty spaces, like pollinator beds, or aquaponics to expand garden learning beyond edible plants. Accessibility can be an issue in gardens, and with

schools as educational institution at least some of the garden spaces should be fully accessible by wheelchair, or any student with physical disabilities.

Faculty Questionnaires

This research sought input from the educators that use the gardens to provide details on how the design of the garden may help or hinder their teaching in the garden setting. A short digital questionnaire was prepared through Qualtrics to distribute to faculty at each site. The questionnaire was approved through the University of Georgia's Institutional Review Board on July 18, 2018. Once distributed, the questionnaire remained active for three to four weeks. The recruitment email for the questionnaire included a consent letter detailing the intention of the research. This and a full copy of the questionnaire, are included in Appendix A. The questionnaire had a total of ten questions which included: grade level of instruction, subject of instruction, average number of students per class, frequency of use of the garden in lessons, lesson topics used in the garden, and likes and dislikes on the layout of the garden. In total, there were 50 questionnaire responses returned: four from Chamblee, one from Champion, 14 from Druid Hills, five from Tucker, nine from Clarke, and 17 from Hilsman. Out of the 50, 18 of the responses contained minimal data or information not pertinent to the aim of this study (e.g. just grade level, subject, number of students, and frequency of use), or they did not answer the final consent response to the questionnaire. These responses were discarded from the research and analysis: leaving 32 responses for analysis, three from Chamblee, one from Champion, six from Druid Hills, five from Tucker, five from Clarke,

and twelve from Hilsman. Below is a summary of the questionnaire responses; the complete responses for all schools are included in Appendix B.

Survey Responses

This section summarizes and analyzes the 32 faculty questionnaire responses. The responses have been sorted into four categories: subjects of instruction, lesson topics in the garden, components of the garden that teachers like, and improvement or change recommendations from the faculty. Each category will include a description of the responses gathered followed by an analysis of the responses and their relevance to school garden design.

Table 1. Subjects of Instruction
Responses are ranked from most frequent response to least frequent response

Subject	**# of Responses**
1. Science	(10)
2. English Language Arts	(7)
3. Math	(4)
4. Social Studies	(3)
5. Family and Consumer Sciences	(2)
6. Special Education	(2)
7. Social Skills	(1)
8. Academic Coach	(1)
9. Technology	(1)
10. Spanish	(1)
11. Agriculture	(1)
12. Art	(1)
13. Orchestra	(1)

Subjects of Instruction

Table 1 summarizes the subjects of instruction from the questionnaire responses. From the questionnaires, it was not surprising to find that science classes are the most active in the garden. Though there were several responses from English Language Arts most of the teachers did not specify what they use the garden for, though two of the teachers mentioned using the garden in certain writing units. Two of the English Language Arts teachers expressed interest in learning how they could incorporate the garden into their lessons. Other subjects whose instructors responded to the questionnaire but are not using the gardens include academic coach, technology, Spanish, math, and orchestra. As discussed in Chapter 2 of this research, research has shown that there is a diverse range of curriculum materials that can be taught in a garden space. The more subjects that use the garden the more imbedded the gardens become in the school culture.

Instructors feel limited in using the garden because they do not understand how to incorporate it into their lessons. This is a topic for future research, as it cannot be addressed in garden design guidelines.

Table 2. Lesson Topics in the Garden
Responses are ranked from most frequent response to least frequent response

Topic	**# of Responses**	**Topic**	**# of Responses**
1. Gardening	(4)	15. Aquaponics	(1)
2. Soils	(3)	16. Erosion	(1)
3. Photosynthesis	(3)	17. Seasons	(1)
4. Composting	(3)	18. Seasonal Eating	(1)
5. Food Preparation	(3)	19. Vitamins and Minerals	(1)
6. Pollination	(2)	20. Human body systems	(1)
7. Food Web	(2)	21. Sales	(1)
8. Symbiosis	(2)	22. Economy	(1)
9. Insects and organisms	(2)	23. Resources	(1)
10. Agriculture	(2)	24. Math in nature	(1)
11. Plant ID and Anatomy	(2)	25. Shapes and patterns	(1)
12. Ecological Impacts	(1)	26. Pythagorean Theorem	(1)
13. Biodiversity	(1)	27. Equations	(1)
14. Sunlight	(1)	28. Poetry / Writing	(1)

Lesson Topics in the Garden

Table 2 summarizes the lesson topics that are currently being taught in the school garden sites. The majority of the topics taught in the gardens are science based. Many of the topics center around plants, gardening, and food. The responses gathered in the questionnaire show some topics that connect the gardens to math, social sciences, and even language arts. Math in the garden seems to focus on shapes and patterns, geometry, and learning basic equations. Social sciences use the garden spaces for learning basics of sales, economy, and resources. English Language Arts classes only seem to use the gardens for writing medium. These topics provide understanding on the subjects the

garden is used for and the gardens should be designed with these topics in mind. It is also possible for the garden to be designed to fill some of the curriculum demands of other subjects not currently using the gardens, to incorporate more users and subjects into the outdoor learning space.

Table 3. Faculty Likes of the Garden
Responses are ranked from most frequent response to least frequent response.

Design			
	# of Responses		**# of Responses**
1. Accessible/Convenient	(3)	4. Close to school	(2)
2. Plenty of Space	(2)	5. Close to water	(1)
3. Close to compost	(2)	6. Raised beds	(1)

Learning			
	# of Responses		**# of Responses**
1. Interactive	(9)	15. Problem solving	(2)
2. Grow food	(8)	16. Urban farming	(1)
3. Outside	(6)	17. Science	(1)
4. Real world experience	(5)	18. Social skills	(1)
5. Nature / Environment	(4)	19. Pest control	(1)
6. Life skills	(4)	20. Relatable	(1)
7. Relaxing	(4)	21. Life cycles	(1)
8. Community building	(4)	22. Sustainability	(1)
9. Movement	(3)	23. Diet & Nutrition	(1)
10. Responsibility	(3)	24. Business	(1)
11. Understanding	(3)	25. Soil	(1)
12. Gardening	(2)	26. Animals	(1)
13. Inspirational	(2)	27. Pride	(1)
14. Writing	(2)		

Faculty Likes of the Garden

Due to the fact that so many of the responses to this question in the questionnaire were more in reference to learning, these responses are in two categories: design and learning. Table 3 shows the responses received for each group. The responses for design make it clear that instructors prefer the garden to be close to the school and to have water and compost areas readily accessible. The response of "plenty of space" came from Hilsman Middle School. Only one faculty member specifically mentioned that they like having raised beds.

Responses that are more focused on the benefits of learning in the garden may not seem to directly relate to the design of the gardens, but they provide insight on garden learning. Some of these learning responses inform design strategies that support stated benefits. For example, if a positive characteristic of a garden is identified as "relaxing", this can translate to designing calm, reflective spaces for students and faculty to use for relaxation.

Table 4. Improvements and Changes Desired

Ranked from most frequent response to least frequent responses

	# of Responses
1. Increase size	(10)
2. Maintenance and management	(9)
3. Increase amount of seating	(5)
4. Centralized garden information center	(5)
5. More tools	(4)
6. Designated classroom area	(4)
7. Good visibility	(4)
8. Close to school building	(4)
9. More plant variety	(3)
10. Connect with more classes and school culture	(3)
11. Student behavior and distractions	(3)
12. Financial support	(2)
13. Irrigation system	(2)
14. Improve use for year-round	(2)
15. Provided shaded areas to escape heat	(2)
16. More work spaces / tables	(2)
17. More accessible	(2)
18. Clean up system	(2)
19. Reflection area	(1)
20. Water feature	(1)
21. Geometric forms	(1)
22. Community outreach	(1)
23. More planting bed styles	(1)
24. Native plants	(1)

Improvements and Changes Desired

Table 4 is a synthesis of the responses related to dislikes and improvements desired by the respondents. The responses in this section of the questionnaire are the most influential to this research on school garden design. The most common response was that the garden spaces are too small, limiting the number of users as well as the variety of plants in the garden. Another common response was that the gardens are challenging to maintain and manage, especially over school breaks and weekends. Based on these two issues, it is apparent that the gardens need to be designed more effectively to allow for more users, and that the design of the gardens should reduce maintenance demands as much as possible. Seating and tables for student work space was another recurring response. Visibility and proximity of the garden to the school was an important feature for instructors, so as to decrease the time wasted by moving the class from the classroom to the gardens. Some of the faculty responses requested a designated outdoor classroom area in addition to other seating. Two faculty members expressed concerns that the gardens are currently disconnected from the rest of the school culture. This is where incorporating the gardens into multiple subjects can better incorporate the space into the school culture.

Two unique ideas presented include the cleanup system and the use of geometric forms. For the clean-up system, a faculty member mentioned creating a routine clean up regimen for students so that the tools, garden, and the school are left in the best condition after each use. The use of geometric forms was suggested by a math teacher to help provide real world connections for learning shapes and geometry. These responses

provide valuable insight on the flaws of existing garden spaces that can be mitigated by design.

Faculty Questionnaire Conclusions

In analyzing and finding connections between the 32 faculty questionnaire responses several commonalities arouse that apply to the design of school gardens spaces. These include existing design practices in the gardens as well as insight on additional principles that should be incorporated into the design considerations of a school garden space. Below is a summary of the findings from the faculty questionnaires that relate to the design of school gardens.

1. The garden should be designed to incorporate numerous curriculum subjects and topics to permit more comprehensive use of the garden by the school.
2. The garden should be designed to foster the learning benefits of school gardens (e.g. interactive, relaxing, community building, connection with nature, skills building, and problem solving).
3. The garden should be located close to the school building, water, and compost area for ease of access and use.
4. If space allows, the garden should be designed to accommodate multiple classes at the same time. If space is limited, the design should use the areas as efficiently as possible without making the areas too small to function.
5. The garden design should help to reduce the maintenance demands of the garden, like incorporating irrigation systems.

6. The gardens should provide ample seating, with some for reflection and other seating for work spaces.
7. If the space permits, an outdoor classroom should be included in addition to the other seating options.
8. Designs for the gardens should make them usable year-round.
9. A shaded area or shelter is needed to provide protection from the elements, especially the sun during the hot months of school.
10. The garden should be accessible to all students.
11. The space should incorporate a variety of plants, not just edible plants, to allow for more learning opportunities.
12. If size permits, the garden should incorporate a variety of planting bed styles.

Case Study Conclusions

The case study research has provided valuable insight on the function and design of some existing school gardens. The site inventories provided information on how the existing gardens are laid out and common elements in a school garden. The faculty questionnaires then provided additional insight on how these gardens actually function. The questionnaires helped to define some of the design features of school gardens that were beneficial and some that pose challenges in the garden. This information was invaluable to define some guidelines to help reduce some of the challenges in school garden learning. The findings discussed in the site inventory section and the faculty questionnaire section are used to define the design guidelines and recommendations in Chapter 6 of this research.

CHAPTER 5

Theory Exploration

School gardens used for education have a variety of unique challenges to meet. Some of these challenges could be solved by looking to other design typologies for potential solutions. Taking techniques that have been implemented and utilized by other types of garden design and modifying them for the unique demands of school gardens can help create a better framework for school garden design. This research is focused on three existing design typologies: home garden design, community garden design, and permaculture design principles. The theories and practices of each typology were explored to determine some of the standard design practices behind each typology. Then the practices identified are reviewed for potential application to school garden design. The review of these existing theories allows the design recommendations for school gardens to be built upon existing knowledge and design standards.

To help connect these design principles from the typologies, it is important to define some of the current challenges of school garden spaces. These challenges are compiled from the case study findings of this research as described in Chapter 4, and findings from other school garden research as described in Chapter 2. One common challenge is time; limited time to maintain the gardens, time for lesson planning, and even time to relocate the class to the garden spaces (Hirschi 2015). A second challenge is not connecting the garden to the school curriculum (Hirschi 2015). This is both a design challenge and a lesson planning challenge. Limited space can challenge the

incorporation of a garden which needs to provide growing space as well as gathering spaces for classes. Insufficient support also limits school gardens; they require financial support, coordination, and maintenance (Hirschi 2015). Access and visibility can be a concern. If the garden cannot be readily accessed, it takes up more class time to access and use. Finding a way to use the garden year-round is also a problem, since much of the growing season is in the summer when school is not in session (Hirschi 2015). Managing the garden during school breaks and over the summer is a common burden to school garden sustainability. Lastly, vandalism can be an issue with these gardens in some areas (Hirschi 2015). These are just some of the most reoccurring issues that school gardens seem to face.

This research is working to identify predefined garden design techniques that could be applied to school gardens. The research will not cover general garden design principles that are used in all types of garden design, such as evaluating existing site conditions, soil conditions, water access, compost, and other similar general gardening techniques.

Home Gardens

While investigating different styles of home gardens, this research focused on the traditional home kitchen garden. Kitchen gardens have been utilized in some form or another for centuries (Time-Life 1999). These gardens were used to readily provide the house with fresh produce and herbs (Bartley 2006, Pavord 1996, Time-Life 1999). Kitchen gardens were intentionally located near the kitchen for ease of use. The original European style kitchen gardens would have provided the bulk of produce for the

household's use, occasionally supplemented by orchards and cereal crop fields (Bartley 2006, Pavord 1996, Time-Life 1999). Though these gardens had a utilitarian purpose, they were often formally designed to blend into the rest of the house gardens (Bartley 2006). It is this utilitarian purpose of the garden that could lend some principles and guidance to the design of school gardens. Kitchen gardens attempt to make the most of the space available and are very practical in function. These features could translate well into school garden design.

Though there is a wide variety of kitchen garden designs, there are some principle design elements that are incorporated into every design and define a kitchen garden. These principles include garden location, bed styles, layout design, enclosure, vertical space, and winter function. Each one of these principles is detailed below with an explanation of the principle in kitchen garden design and how that can translate to the needs of a school garden. Figures 9 and 10 show an example of a kitchen garden and illustrate the use of some of the principles described below.

Powell House Kitchen Garden
Williamsburg, VA

Legend

A. Location
B. Bed Styles
C. Enclosure
D. Layout

Figure 9. Aerial view of the Powell House kitchen garden. Google Maps, Powell House Williamsburg, VA.

Figure 10. Powell House kitchen garden. Colonial Williamsburg Foundation.

Location

Kitchen gardens are located close to the kitchen within easy access of a building entrance, but in an area that has adequate sunlight for production, typically six or more hours a day (Bartley 2006, Pavord 1996, Time-Life 1999). If possible, the gardens should be within easy daily viewing so they can be inspected even during inclement weather (Bartley 2006). The proximity of the garden to the residence is a defining principle of the design.

Analysis:

This principle of garden location and ease of access is an important factor for school garden design. Findings from the case studies in Chapter 4 as well as previous research emphasize that school gardens should be close to building access and as close to classrooms as possible. This close proximity helps to reduce time for classes to access the garden for lessons.

Bed Styles

Historically, kitchen gardens were all in-ground beds between formal pathways. Modern kitchen gardens are more frequently raised beds (Bartley 2006). Raised beds are a convenient way to control the quality of the garden soil and can be easier to work in because they can reduce the amount of bending over necessary to tend the garden bed. In-ground beds are less expensive, but the soil often requires amendments and should be tested for contaminates to make sure the food produced will be safe to eat (Bartley 2006, Pavord 1996, Time-Life 1999).

Analysis:

Chapter 4 findings reveal that school gardens are often raised beds, but if the space is available both bed styles could be implemented, and students can learn about the advantages and disadvantages to each bed style. This also fits the challenge of meeting more curriculum topics by providing a diversity of growing mediums.

Layout

Kitchen gardens utilize geometric shapes to lay out the beds and pathways. Most of the time, the layout is a combination of rectangles, squares, and triangles. This use of geometric forms comes from the desire to blend the kitchen garden with the rest of the formal gardens of the house, which also utilized geometric forms in their design (Bartley 2006, Pavord 1996). Kitchen gardens also use repetition to help unify the space (Bartley 2006). Individual beds are usually only three to four feet wide to allow access to tend the bed without entering it. Larger plots have small access aisles to allow for tending the crops. Main pathways are usually at least three feet wide to accommodate garden carts, while secondary paths may only be one to two feet wide, enough to accommodate access for one gardener (Bartley 2006, Pavord 1996, Time-Life 1999).

Analysis:

Geometric forms are an easy way to organize spaces and tend to be easier to build, thus easier to achieve at a school with limited resources. For school garden path design, it is important to consider the use of the space such as if carts will be used and from what direction the gardens should be accessed. Using the layout basics of a kitchen

garden can help the findings from the case studies in Chapter 4 related to issues of spatial organization, access, and maintenance of the garden.

Enclosure

Traditional kitchen gardens are enclosed. This was done to help keep out animals, to create protected microclimates, and to create a formal edge to the garden space. Enclosures for the garden varied from walls, fences, or even plants (Bartley 2006, Pavord 1996, Time-Life 1999).

Analysis:

School gardens may consider enclosing the garden for the same reasons as listed above and for the additional objective of deterring vandalism, an issue revealed by previous research.

Vertical Space

Since kitchen gardens are often in smaller spaces, space is used as efficiently as possible, which means taking advantage of growing vertically. There are numerous climbing and vining vegetables and fruits that can be trained to grow up fences, walls, trellises, and other structures (Bartley 2006, Time-Life 1999). Another option to take advantage of the vertical plane is to use espalier fruit trees, which are trained to grow flat against a structure or wall (Bartley 2006, Time-Life 1999).

Analysis:

School gardens often have space limitations, so vertical gardening methods could be considered. Making efficient use of garden space was a concern in the case study findings in Chapter 4 as well as in previous school garden research.

Winter Function

Since kitchen gardens provide food for the household, gardeners would try to produce as long as possible, rotating crops and using cold season crops to keep production going into the winter (Bartley 2006). Also, kitchen gardens often have perennial and evergreen plants to provide interest and structure to the garden in the winter months (Bartley 2006). The intention is to have a beautiful garden year-round since it is located so close to the household and is so visible.

Analysis:

A common challenge of school gardens is year-round use. This was found both in previous research and in the faculty questionnaire responses in Chapter 4. To help support educational objectives throughout the school year, school gardens could include the winter functions of a kitchen garden. Crop rotations, perennial plants, and evergreen plantings could be incorporated for continued use even after the standard growing season has passed.

Home Garden Conclusions

Table 5. Home Garden Design Connections to School Gardens.

		School Garden Design Issues								
		Time	Maintenance	Ease of Access	Curriculum	Space	Support	Year Round	Breaks/ Summer	Security
Home Garden Design Characteristics	Location									
	Bed Style									
	Layout									
	Enclosure									
	Vertical Space									
	Winter Function									

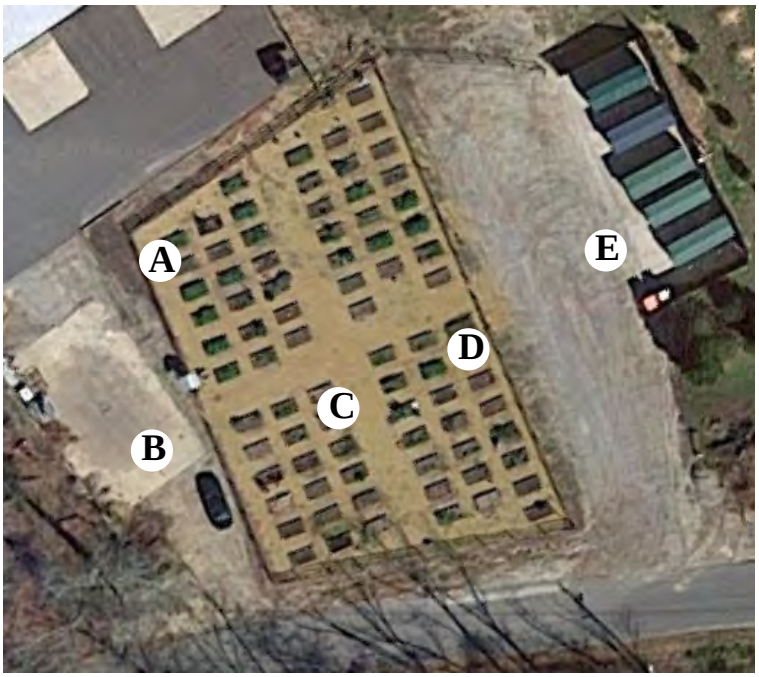
As described at the beginning of this chapter there are several challenges and demands that are commonly found for school gardens, based on the case study findings of this research as well as previous research on school gardens. Table 5 above shows the principles of kitchen gardens and how they connect to the defined challenges and demands of school gardens.

Community Gardens

Community gardens are garden spaces created for and used by a community. There are two types of community gardens in the United States. One type is a garden that is shared by the community and belongs to all members; the garden is cared for and harvested by all members. The other type is based on the European allotment garden where members rent plots that they each manage and harvest on their own (Bell 2016, Naimark and Boston Urban 1982). This research is focused on the allotment style community garden, because school gardens are used by multiple groups at the same time, similar to the way allotment gardens are used by multiple member groups at once. Community gardens have continued to grow in popularity since the 1970s (Hirschi 2015). They were a response to the increasing demands for growing space in dense urban areas where people may not have access to outdoor spaces to garden. They also arose from the desire to bring the community together and strengthen community relationships (Hou 2009). With the large variety of users, community gardens are designed to facilitate easy access to the garden spaces for all users.

This research looks at some of the design principles that define community gardens and their use for school gardens. These include layout design, enclosure, rules, accessibility, security, facilities, ornamental plantings, and communal spaces. The next section details the principles in designing community gardens and how the techniques can relate to school gardens. Figures 11 and 12 provide an example of a community garden in Winterville, Georgia.

Winterville Community Garden
Winterville, GA



Legend

A. Ornamental Plantings
B. Rules
C. Layout
D. Enclosure
E. Facilities

Figure 11. Aerial of the Winterville Community Garden. Google Maps Winterville, GA.

Figure 12. Photos of information kiosk with rules and garden entrance. (taken by author)

Layout

The layout of a community garden starts by looking at the size of the land and defining the desired size of the allotment plots and any desired communal spaces. Plot sizes vary, but some of the commonly used sizes are: 10' x 10', 15' x 15', 20' x 20' (Harmon 2010, Hou 2009, Naimark and Boston Urban 1982). Plot sizes should be consistent throughout the site, giving each user the same amount of growing space (Hou 2009). Individual plot renters set up their own growing beds to their own preference (Harmon 2010, Hou 2009, Naimark and Boston Urban 1982). Many community garden users prefer raised beds to help improve the soil conditions. Between the individual plots are walkways and access aisles. Much like with kitchen gardens, the main pathways in community gardens are typically three feet wide or more to accommodate garden carts and wheelchairs (Harmon 2010, Hou 2009, Naimark and Boston Urban 1982).

Analysis:

School garden beds could be designed for use as individual plots. Plots could be designated for each grade level, each class, each team, or even subdivided for individual students. This division of the planting beds can allow for more equitable division of the garden space and create a sense of ownership by each group.

Enclosure

Community gardens are typically fenced or enclosed. This enclosure can keep out unwanted visitors, animal or human (Harmon 2010, Hou 2009, Naimark and Boston Urban 1982). If fenced, the fencing has gates for people to enter, usually at least three

feet wide, and may include one gate that is at least 10 feet wide to allow for truck access for deliveries (Naimark and Boston Urban 1982).

Analysis:

As with kitchen gardens, school gardens may benefit from enclosure, either for security or to keep out animals that might damage them.

Rules

Most community gardens have a set of rules for users and visitors. Visitor rules may be posted at the site for people to view. User rules are distributed to users when they lease their plots (Harmon 2010, Hou 2009). These rules help to maintain the gardens and keep expectations of users on the same level (Harmon 2010, Hou 2009). Rules can be very general or more restrictive. It varies from each community garden and the desires of the community group managing the garden (Harmon 2010, Hou 2009). Examples of rules are asking visitors to not disturb the plantings or asking users to adhere to certain maintenance guidelines.

Analysis:

Schools may want to establish a set of agreed upon rules for all users such as procedures for tools, clean up, or harvesting. Similar to rules in classrooms that students must follow, the school garden, which is an outdoor classroom, should have rules. Having rules for the garden can help manage time, reduce maintenance demands, and support the use of the gardens by classes. This helps to meet some of the challenging demands of school gardens as found through the case study questionnaire responses discussed in Chapter 4 and in previous school garden research discussed in Chapter 2.

Accessibility

Since many community gardens are in public spaces, they are designed to be accessible to people with various disabilities. Gardens that incorporate accessibility will have Americans with Disability Act compliant walkways (smooth hard surfaces with slopes less than 5%) (Harmon 2010, Hou 2009). They may also have raised accessible planting beds, accessible facilities, and may use contrasting materials to help with visual disabilities (Harmon 2010, Hou 2009).

Analysis:

For a school garden to be fully inclusive of all students, at least a section of the garden should be accessible to students with disabilities, such as having wheelchair access and raised beds. Many existing school gardens do not have this feature, which limits the ability of some students to be able to utilize the garden. Accessibility was also an issue that was included in the findings from the case studies in Chapter 4.

Security

A common issue with community gardens is security and vandalism. Literature on community gardens recommends locating the garden in a visible area where vandals are less likely to act (Naimark and Boston Urban 1982). Fencing can help deter vandalism but does not always prevent it. Many community garden groups have found reduced security issues when the garden is located next to areas that are frequently used, such as parks, businesses, or residences (Hou 2009).

Analysis:

School gardens can face these same security and vandalism risks. Since the gardens are on the campus, they fall within the campus security measures, which may include fencing or cameras. Additional security may be needed around the garden area if the existing security measures do not cover it. Security is an issue that is commonly discussed in previous research and came up in the findings from the case studies in Chapter 4.

Facilities

Community gardens may include a variety of facilities, from storage sheds to gathering spaces, trash receptacles, compost, recycling areas, material storage, information kiosks, or restrooms (Harmon 2010, Hou 2009, Naimark and Boston Urban 1982). These are areas that all users of the garden may utilize.

Analysis:

School gardens may not require all the same facilities as a community garden but as shown through the case studies in Chapter 4 there are several structures and facilities that are common in school gardens, like storage sheds, compost areas, and greenhouses.

Ornamental Plantings

The perimeter and common areas of community gardens often include non-edible plantings. These plantings are used as barriers or screens, to provide shade, attract pollinators, or even just to beautify the space (Harmon 2010, Hou 2009, Naimark and Boston Urban 1982).

Analysis:

It is common to plant ornamental plants near food production plants to attract pollinators. In a school setting, ornamental plantings around or near the edible gardens could be themed to a variety of curriculum topics. Examples are pollinator gardens, use of native plants, a heritage garden, or literature garden. It is important to note that no toxic plants should be planted near an edible garden in case they are accidentally ingested. By incorporating ornamental plantings, the gardens could be used for more seasons and by more subjects, a need identified in Chapter 4.

Communal Spaces

Some community gardens include areas with more permanent edible plantings, such as fruit and nut trees, fruiting shrubs, or perennial herbs. These spaces become communal gardens, and often the garden users develop their own terms on maintaining and harvesting the communal areas (Harmon 2010, Hou 2009, Naimark and Boston Urban 1982). This allows for gardeners to gain the benefit of produce from perennial crops while focusing their individual plot spaces for annual crop production.

Analysis:

Fruit trees, fruiting shrubs and vines, or other perennial food plants that take up too much space in small individual beds could be planted in communal areas allowing students to learn about more than just annual food crops. Consolidating these perennial crops in communal garden spaces of the school garden requires less space and

maintenance and allows for more seasonal use of the garden, addressing desires documented in Chapter 4.

Community Garden Conclusion

Table 6. Community Garden Design Connections to School Gardens.

		School Garden Design Issues								
		Time	Maintenance	Ease of Access	Curriculum	Space	Support	Year Round	Breaks/ Summer	Security
Community Garden Design Characteristics	Layout		■	■		■				
	Enclosure					■				■
	Rules	■	■				■			
	Accessibility	■		■						
	Security									■
	Facilities		■			■		■		
	Ornamental Plantings		■		■			■		
	Communal Spaces		■		■	■		■		

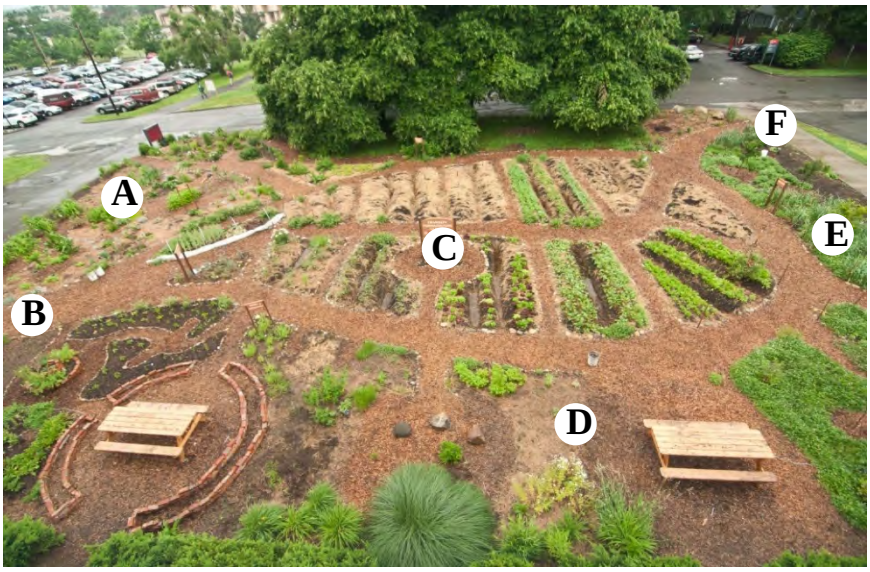
To look at how community garden design principles relate to school gardens, Table 6 provides a quick review of the design principles in relation to some of the common challenges and demands of school garden design. These challenges and demands are taken from the findings of the case studies in Chapter 4 as well as previous school garden research discussed in Chapter 2.

Permaculture Design

The term permaculture was first used in the 1970s in Australia when Bill Mollison and David Holmgren decided to make an agricultural system modeled after ecological systems (Faires 2012). The term refers to the way these systems create more permanent agricultural practices that take less effort and are more ecologically resilient (Faires 2012, Falk 2013, Hemenway 2009). As Bill Mollison described it, "Permaculture is a philosophy of working with, rather than against nature" (Faires 2012). This novel way of creating food systems has continued to grow in popularity since its inception. Permaculture gardens focus on creating systems that increase ease of use and are built to become self-sustaining in many ways. The principle behind permaculture design is that if everything is planned correctly the gardens should require less work and effort to maintain while increasing production and yield (Faires 2012, Falk 2013, Hemenway 2009).

Below are some of the defining characteristics and principles that influence permaculture design. These include layout with zones and sectors, forms and patterns, plant diversity, multifunctionality, planting guilds, perennial crops, soil building, and water usage. These are described below and discussed on the relation of these practices to school garden design. Figure 13 includes an example of a demonstration permaculture garden at the University of Massachusetts.

Franklin Permaculture Garden
Amherst, MA



Legend

A. Plant Guilds
B. Forms and Patterns
C. Layout
D. Soil Building
E. Perennial Crops
F. Water Usage

Figure 13. Aerial view of the Franklin Permaculture Garden at University of Massachusetts. Image from Ryan Harb, Smith Ceeds.

Layout

The layout of a landscape utilizing the principles of permaculture is based around the zones and sectors system in permaculture. There are up to six zones in a permaculture garden and a variety of sectors. Figure 14 is a graphic showing how the zone system is organized.

The zones are:

- Zone 0 which is the house or building.
- Zone 1 is the area immediately adjacent to zone 0 and is the most frequently used and heavily maintained garden spaces.
- Zone 2 is beyond zone 1; it is still used daily, but only once or twice a day and requires less maintenance than zone 1.

- Zone 3 is for larger orchards, animals, and cash crops; this zone is visited and maintained a few times per week.
- Zone 4 is beyond zone 3; it requires minimal care and includes woodlots, grazing areas, and forest gardens.
- The last zone is zone 5 which is unmanaged, not actively harvested, and only occasionally visited.

  (Faires 2012, Falk 2013, Hemenway 2009)

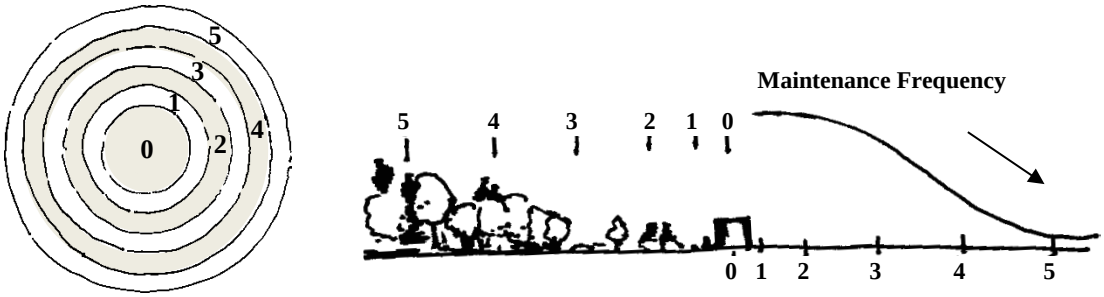


Figure 14. Permaculture zone system.

The zone system concentrates the more demanding, high use spaces closest to the structure. The sectors note areas on the site that have specific attributes or influences. These include sun, views, pollution, wildlife, fire, water, or crime. The sectors help to organize the functions of areas in the garden (Faires 2012, Hemenway 2009).

Analysis:

A modified set of zones could be used to help organize a garden for schools. Location is an important element in school gardens and good spatial organization is essential to making sure the space works efficiently. Organizing a school garden following the zone model could ease maintenance and allow for the more frequently used spaces to be the easiest to access. The findings presented in Chapter 2 and 4 present maintenance, space, and time as challenges to garden success.

Forms and Patterns

Many of the forms used in the design and layout of permaculture gardens are derived from natural shapes and forms. Using some of these patterns can help to save space and make the garden more efficient to maintain (Faires 2012, Hemenway 2009). There are four common forms used in permaculture gardens. These are: keyholes, spirals, branching, and net forms. Keyhole gardens create small spaces just off a path that are surrounded by growing space. This form is used to reduce the number of paths and increase the amount of production space (Faires 2012, Hemenway 2009). Spiral forms can be used to increase access to bed areas or used to build beds vertically to increase growing space on less ground. Branch forms, like tree branches, have a central path with small paths all stemming from the central path, concentrating growing space with less path space (Faires 2012, Hemenway 2009). Lastly, the net form, or grid, creates an evenly spaced network of plants, as in orchards (Faires 2012, Hemenway 2009). Figure 15 below shows examples of these permaculture forms.

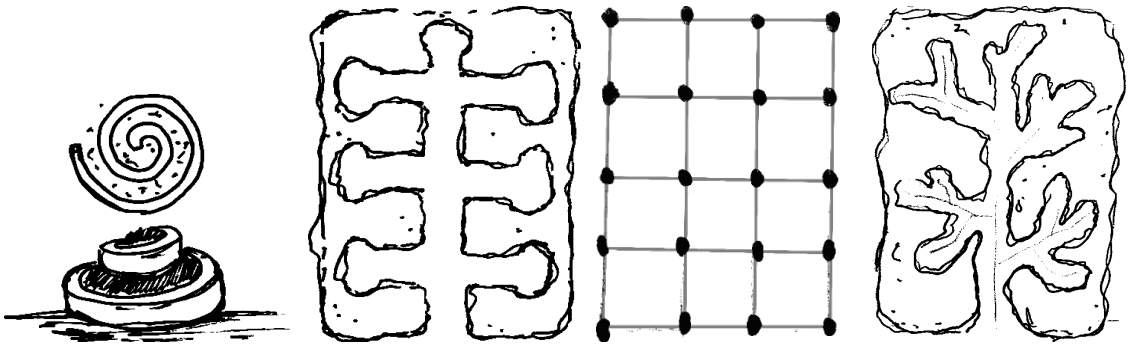


Figure 15. Permaculture forms.

Analysis:

Though simple geometric forms like rectangles are easy to design and build, adding some of these more space saving forms from permaculture design could be a more effective use of garden space in school gardens, especially if space is limited. Also, some of these forms can be used in lessons expanding curriculum topics in the garden a need identified in Chapter 4. For example, a spiral form could be created using the Fibonacci sequence, a salient topic in math and art.

Plant Diversity

A key to permaculture sustainability is plant diversity; this helps to create healthy growing systems and long-term yields (Faires 2012, Falk 2013, Hemenway 2009). Plant diversity leads to animal and insect diversity, which helps to keep the planting systems within permaculture gardens healthy with less human input (Hemenway 2009).

Analysis:

School gardens are often limited by the amount of work that has to go into maintaining them, as discussed in the case study findings of Chapter 4. Plant diversity can to reduce the amount of work people need to maintain the gardens by creating healthy systems and allowing specific plants to serve some of the maintenance functions, such as mulch or fertilizer. Also, diversity provides learning opportunity; the more species grown, the more students can learn about a broader ecosystem.

Multifunctionality

In permaculture, ideally, everything serves multiple functions (Faires 2012, Falk 2013, Hemenway 2009). In addition to producing food, plantings may also provide nitrogen or other nutrients, provide living mulch, repel or attract insects, improve soil, or encourage beneficial wildlife relationships (Faires 2012, Falk 2013, Hemenway 2009).

Analysis:

As with diversity, the goal of having a multifunctioning system of plants is to reduce maintenance and to reduce chemical treatments that may be needed to maintain plant health and production. Findings in Chapter 4 show that school gardens could benefit from reductions in the time needed to maintain them. Multifunctionality can also provide a living example of the interdependent relationships of plants and animals.

Plant Guilds

The most unique feature of permaculture gardens is that plants are combined to create plant communities, as in natural systems. These communities are characterized by layered vegetation, creating multiple stories or functions, and system support (Falk 2013, Hemenway 2009). Communities are produced by interplanting crops, companion planting, or forming polycultures which are groups of plants from a variety of families (Falk 2013, Hemenway 2009). One of the most well-known garden guilds is known as the three sisters: corn, beans, and squash. The corn forms a structure for the beans to grow on, and the squash shades the ground acting as a living mulch for the corn and beans. The beans help to fix nitrogen in the soil to feed the corn and squash (Hemenway 2009). Guilds can also be created with a productive tree at the center. Guilds may also

include grass suppressing bulbs, plants to attract birds and insects, plants that are a living mulch or shed materials to create a mulch, nutrient accumulating plants, and plants that act as soil fumigants or that repel pests (Hemenway 2009).

Analysis:

Designing with guilds can create more permanent and self-sustaining agricultural systems. For school gardens, this could greatly reduce maintenance, but it requires much more planning and design to initially implement. Guilds are also more permanent, which means less room is available for annual crops or crop rotations. This planting system is a different type of agricultural practice that offers different learning opportunities for students to learn about self-sustaining production techniques.

Perennial Crops

To create self-sufficient systems, permaculture techniques are usually based on using perennial plants. Using perennial plants reduces replanting and seed starting, helps to eliminate the need to till the soil, and the deeper root systems help build soil quality and health (Faires 2012, Falk 2013, Hemenway 2009). Perennial plants often need less water and nutrients once established and tend to be more drought resistant (Falk 2013, Hemenway 2009). Annual crops are still used in permaculture systems, but they are used to supplement the more permanent perennial crops.

Analysis:

Findings reveal that existing school gardens focus on teaching annual food crops. This provides a limited view of food production systems. Expanding to include perennial crops can extend the seasonal use of the garden since they have variable production

seasons. Using perennial crops meets the demands for year-round functionality of the school garden and wider curriculum topics as referenced in the case study findings of Chapter 4.

Soil Building

A principle of permaculture is to reduce the human input in production, including chemical applications. To do this, it is essential to build healthy, nutrient rich soils (Falk 2013, Hemenway 2009). Permaculture uses many different techniques to improve soil quality, like compost applications, sheet mulching, cover and winter crops, biochar, and manures (Falk 2013, Hemenway 2009). Sheet mulching is one of the most used practices, which is similar to composting in place by applying layers of organic matter in a specific order on top of the soil (Falk 2013, Hemenway 2009).

Analysis:

These soil building techniques take more time than quick amendments and fertilizer, but they are more environmentally sound and create longer lasting results. Many school gardens are already very labor intensive, so soil building may not be an option, but it is important to weigh the lasting benefits that soil building could produce. Also, if any lessons center around soils, then soil building, even in a small area, could add curriculum opportunities, a need identified in Chapter 4.

Water Usage

Water is essential to all garden success. In addition to irrigation and hose connections, many permaculture garden designs include swales and other earthworks to

decrease the velocity of rainwater and increase infiltration (Falk 2013, Hemenway 2009). These water slowing techniques are usually used with other common water conservation and harvesting techniques.

Analysis:

Water can be a critical limiting factor to school garden success. Not all schools can afford an irrigation system. Swales and other earthworks that direct water flow and enhance infiltration can act as a natural irrigation system helping to alleviate some of the water demands of the garden. This method of water control is especially effective if there is a lot of topographic change on the school garden site. Once again, this function helps to reduce maintenance demands of the garden, which is a frequent concern to faculty as described in Chapter 4.

Permaculture Design Conclusions

Table 7. Permaculture Design Connections to School Gardens.

		School Garden Design Issues								
		Time	Maintenance	Ease of Access	Curriculum	Space	Support	Year Round	Breaks/ Summer	Security
Permaculture Design Characteristics	Layout	■	■	■		■				
	Forms & Patterns		■		■	■				
	Plant Diversity		■		■			■		
	Multi-function		■		■		■		■	
	Plant Guilds		■		■	■		■		
	Perennial Crops				■			■		
	Soil Building		■		■		■			
	Water Usage		■			■	■		■	

One of the biggest limiting factors for school gardens is resources to care for and maintain the gardens. Some of the practices and recommendations utilized by permaculture could be applied to school gardens to help reduce the maintenance demands required by this teaching resource. Permaculture techniques can also open more learning opportunities to teach students the complex processes of nature. Table 7 shows a summary of how the permaculture design principles correspond with school gardens.

Existing Theory Conclusions

The investigation into existing design theories provided insight on design principles already in use that can be applied and adapted to school garden design.

Kitchen garden design principles provided techniques to make use of small spaces for food production. Community garden design principles provided insight on designing gardens that are used by numerous groups of people. Permaculture design principles gave a perspective on unique food production techniques to assist in filling the demands of school gardens. A summary of the theory exploration findings is included in Table 8. The findings from the design theory investigations are used to help define some of the design guidelines presented in Chapter 6.

Table 8. Summary of Theory Design Connections to School Gardens

	Theory Design Characteristics	**School Garden Design Issues**								
		Time	Maint. Demands	Ease of Access	Curriculum	Space Org.	Support	Year Round	Breaks/ Summer	Security
Kitchen	Location	■		■						
	Bed Style				■					
	Layout		■	■		■				
	Enclosure					■				■
	Vertical					■				
	Winter				■			■		
Community	Layout		■	■		■				
	Enclosure					■				■
	Rules	■	■				■			
	Access	■		■						
	Security									■
	Facilities		■			■		■		
	Ornamental		■		■			■		
	Communal		■		■	■		■		
Permaculture	Layout	■	■	■		■				
	Forms		■		■	■				
	Diversity		■		■			■		
	Multifunction		■		■		■		■	
	Guilds		■		■	■		■		
	Crops				■			■		
	Soil		■		■		■			
	Water		■			■	■		■	

CHAPTER 6

Design Guidelines and Recommendations

The guidelines and recommendations for school garden design detailed below have been developed from the findings of Chapters 4 and 5. This section combines the results of the case study and theory research to provide a list of design principles specific for school garden design.

Site

1. Location:

   Locate the school garden areas close to the building and as centralized in the campus as possible to allow for quick and easy access by classes and for increased visibility. Ideally the gardens would be less than 100 feet away from a school building entrance.

2. Zones:

   Organize the garden spaces in zones, similar to permaculture landscapes. As previously shown in Figure 14.

Spaces

3. Space:

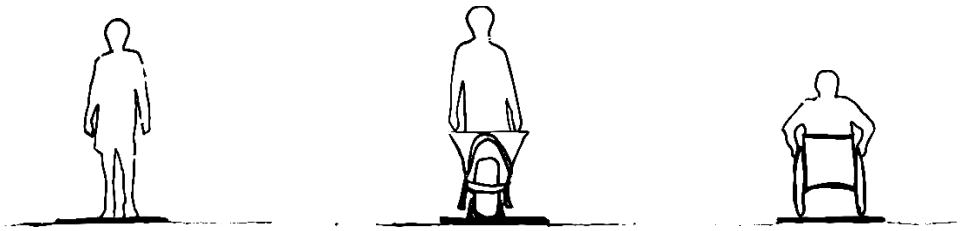
   Design the garden space to accommodate more than one class at a time. This allows for greater flexibility of use.

4. Assign Spaces:

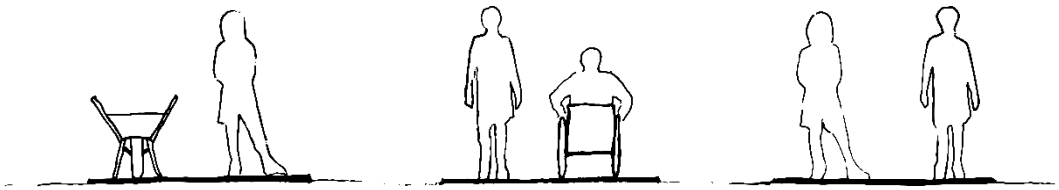
   Designate beds, or areas, for specific classes, groups, teams, or grade levels. This gives ownership of the garden to the classes and students. It also allows for the spaces to be developed to meet individual lesson and curriculum needs.

5. Paths and Aisles:

   Main pathways should average three to six feet wide, with smaller access aisles used as needed off the main paths. When determining the path width, consider the number of students that may require access at one time, as well as access for equipment and wheelchairs. Figure 16 shows the function of walkways, both three-foot-wide and six-foot-wide.



Three-foot Sidewalk Functions



Six-foot Sidewalk Functions

Figure 16. Example path width and uses, three foot and six foot.

6. Accessible:

   At least some of the areas of the garden should be made fully accessible to all students regardless of mobility. This includes paved areas around beds and beds raised high enough to tend from a seated position, 28 – 34” in height.

Soil & Water

7. Soil:

   If time allows, the soil in the garden beds should be built up with nutrients and microorganisms. This can be done with compost incorporations, sheet mulching, or incorporating cover crops. Building up the soil health helps to reduce the need for fertilizers and creates a healthy soil biome for plants. The processes are also a unique educational opportunity on the subject of soils and microorganisms.

8. Water:

   The site should have a reliable water source. This could be as simple as a hose connection but could also include irrigation systems or water harvesting systems.

9. Water Harvesting:

   If space allows, incorporate some water harvesting features. These features can be to store water for later use, like rain barrels and cisterns, or topographic features that help slow and infiltrate water, like swales and depressions.

Structures

10. Seating:

    Seating is important for all school garden spaces. If possible, enough seating and work surfaces for one full class (approximately 20-30 students) should be incorporated in, or near, the garden. Additional seating for relaxation and leisure should be incorporated for students and other users to enjoy the gardens.

11. Outdoor Classrooms:

    If space allows, the garden should incorporate a designated outdoor classroom area in addition to other seating.

12. Shade:

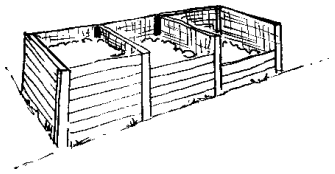
    A shaded area near the garden should be provided so that students can take shelter from the sun on hot days. The shade could be from trees or from shade structures.

13. Storage:

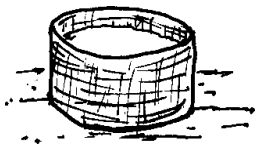
    Every garden space needs a structure to store tools and materials. These structures should be easy to access, near the garden space, and large enough to accommodate the tools and materials for that space.

14. Compost:

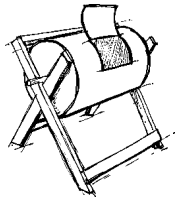
    As per common best practices, a compost area should be readily available in the garden to use for garden waste. There are numerous styles for compost bins to meet the needs of any school garden space, see Figure 17. Larger open bins are more suitable for bigger spaces, smaller barrel or worm compost bins are more suitable for smaller garden spaces or in spaces that odor is not desirable.



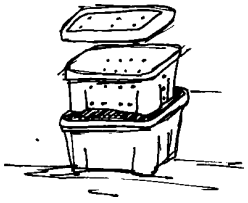
Multi-bin Compost System



Single Bin Compost



Rotating Barrel Compost



Worm Compost

Figure 17. Example of compost bins.

15. Greenhouses:

    If space allows, a greenhouse or propagation structure can be incorporated into the school gardens to extend the growing and learning seasons.

Planting Beds

16. Bed Styles:

    If there is enough garden space, the gardens should incorporate a variety of bed styles, both raised and inground. Bed width is typically 4 feet wide if the bed can be accessed on both sides, and usually 2-3 feet wide if the bed can only be accessed from one side. This is to allow for the gardener to reach everything in the bed without entering the bed. A variety of bed styles offers different growing and learning opportunities in the garden.

17. Raised Beds:

    Raised beds are an easy way to improve soil conditions. If the bed is 18-24" in height it is easier to tend without having to bend fully to the ground. Raised beds are typically geometric in form: square, rectangular or sometimes triangular. These simple shapes are easy to build with standard building supplies and easy to layout in simple rows or grids.

Plantings

18. Variety:

    The gardens should include a wide variety of plants. This allows for more learning opportunities and creates a more biodiverse garden space.

19. Perennial Crops:

    Incorporating perennial crops into the school garden can help to extend the growing season and teach different agriculture principles.

20. Ornamental Plantings:

    Ornamental plantings enhance the beauty and provide additional learning opportunities. Ornamental plantings can be used to create barriers or screens, provide shade, attract pollinators, create specialty garden spaces, or just for user enjoyment.

21. Year-Round Use:

    The school garden should be designed to be used all year long. This includes designing spaces that can be used in any season and developing planting plans that include year-round interest and study.

22. Specialty Gardens:

    Incorporate garden spaces that are themed to meet the school curriculums. The garden space could be for pollinators, aquaponics, native plants, math, shade plants, art, sensory, music, literature, or other topics beyond the edible school garden space.

23. Vertical Gardening:

To more efficiently use space in small gardens, the design should incorporate vertical elements. The garden can incorporate plants that climb, have tall narrow habits, or that can be trained, like espalier fruit trees. Figure 18 below shows some types of vertical gardening structures.

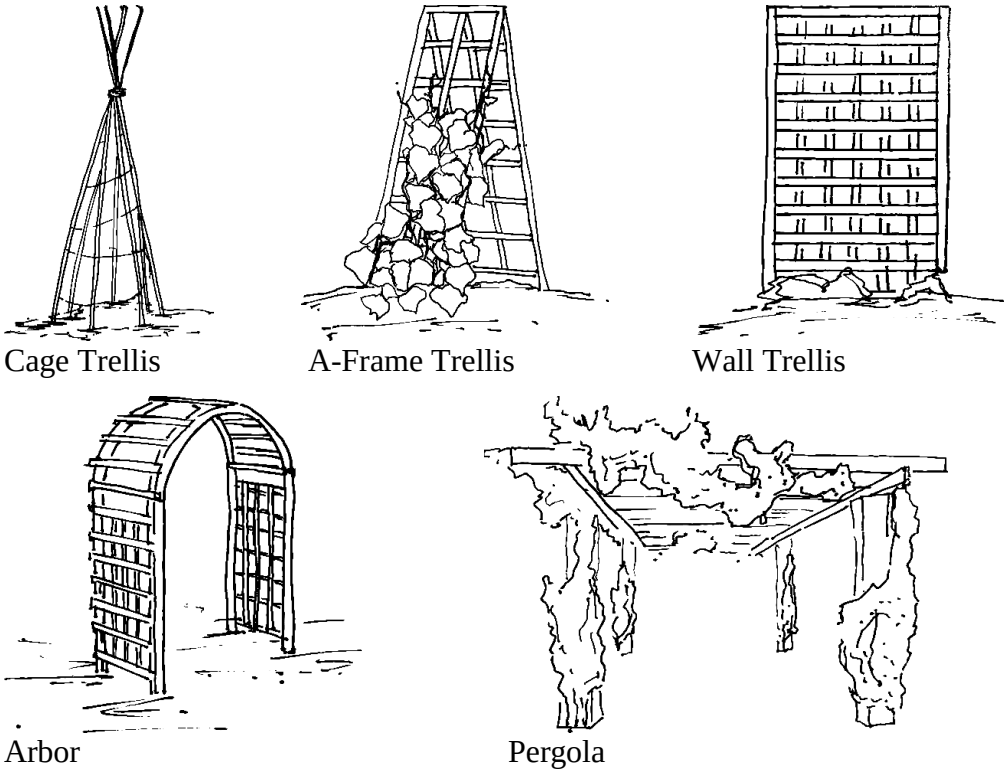


Figure 18. Examples of vertical gardening structures.

24. Natural Forms:

    Geometric forms are a simple way to layout garden spaces but incorporating other forms adds interest and contrast to the garden design. The design can implement natural form styles from permaculture such as the spiral, keyholes, nets, and branches, as described in Chapter 5, or other natural forms that increase efficiency.

Considerations

25. Multifunctional:

    To make the most efficient use of limited space, the areas, plants, and plantings in the school garden should be designed to serve multiple functions.

26. Maintenance:

    The school garden space should be designed to be easily maintained, as will follow if the recommended guidelines are implemented.

27. Benefits:

    Design of the garden space should foster the benefits of educational gardens (e.g. interactive, relaxing, community building, connection with nature, skills building, and problem solving) as discussed in Chapter 2. This can be accomplished by allowing beds and plantings to be accessible for easy interaction, creating calm spaces for relaxation and reflection, or including spaces for gatherings.

28. Curriculum:

    The design of the school garden spaces should facilitate connection to the school curriculum standards. A garden cannot be an effective educational tool if it does not fit into the curriculum and ideally in multiple class subjects. This could be

done working from a developed list of curriculum objectives during the design process.

29. Rules:

    As in classroom, the school garden policy should include rules for using the garden and procedures for using tools and supplies.

30. Enclosure:

    Enclosing the garden helps to define the space and provide security. Barriers six feet or taller are best for security, while shorter barriers can be used to separate spaces.

31. Security:

    School gardens should be protected by campus security measures. Vandalism can occur, so deterrent measures like secured fencing and security cameras should be employed if vandalism has been an issue at the school site.

CHAPTER 7

Design Application

This research has developed a list of guidelines and recommendations for designing school gardens. To investigate the ability to apply these guidelines to an actual school setting, this research will prepare two conceptual school garden designs based on the guidelines defined in Chapter 6. These designs implement and test the ability to apply the defined guidelines to two actual school garden sites. The use of this projective design research strategy is essential to test the interpreted guidelines developed and determine if there is a need for additional research and testing (Deming and Swaffield 2011).

Druid Hills Middle School

Context

Druid Hills Middle School is one of the case study school sites in Dekalb County, Georgia, see Figure 19 for an overview of the school site. A garden update is planned since many of its beds are in disrepair, and the Environmental Club coordinator, Kathy Cochran, has expressed that she has always planned on expanding the gardens at the school. Due to the school's interest in improvements and expansion of the gardens, as well as the unique layout of the school buildings, the site was selected for application of the design guidelines. The school campus is flat and fairly exposed, with a wooded tree line at the back of the school building. The spaces for the school garden include two

interior courtyards that are completely enclosed by the main school building, and three open spaces that are between the main school building and the additional building at the back of the campus. The current school gardens are already in one of the open spaces between the school buildings, but the remaining spaces are not currently being utilized for learning. Figure 20 shows the proposed school garden design for Druid Hills Middle School based on the findings in Chapter 6. In preparation for the design, the Dekalb County School District design guidelines were reviewed to make sure that the garden design stays within the school design standards.

Figure 19. Overview of Druid Hills Middle School site

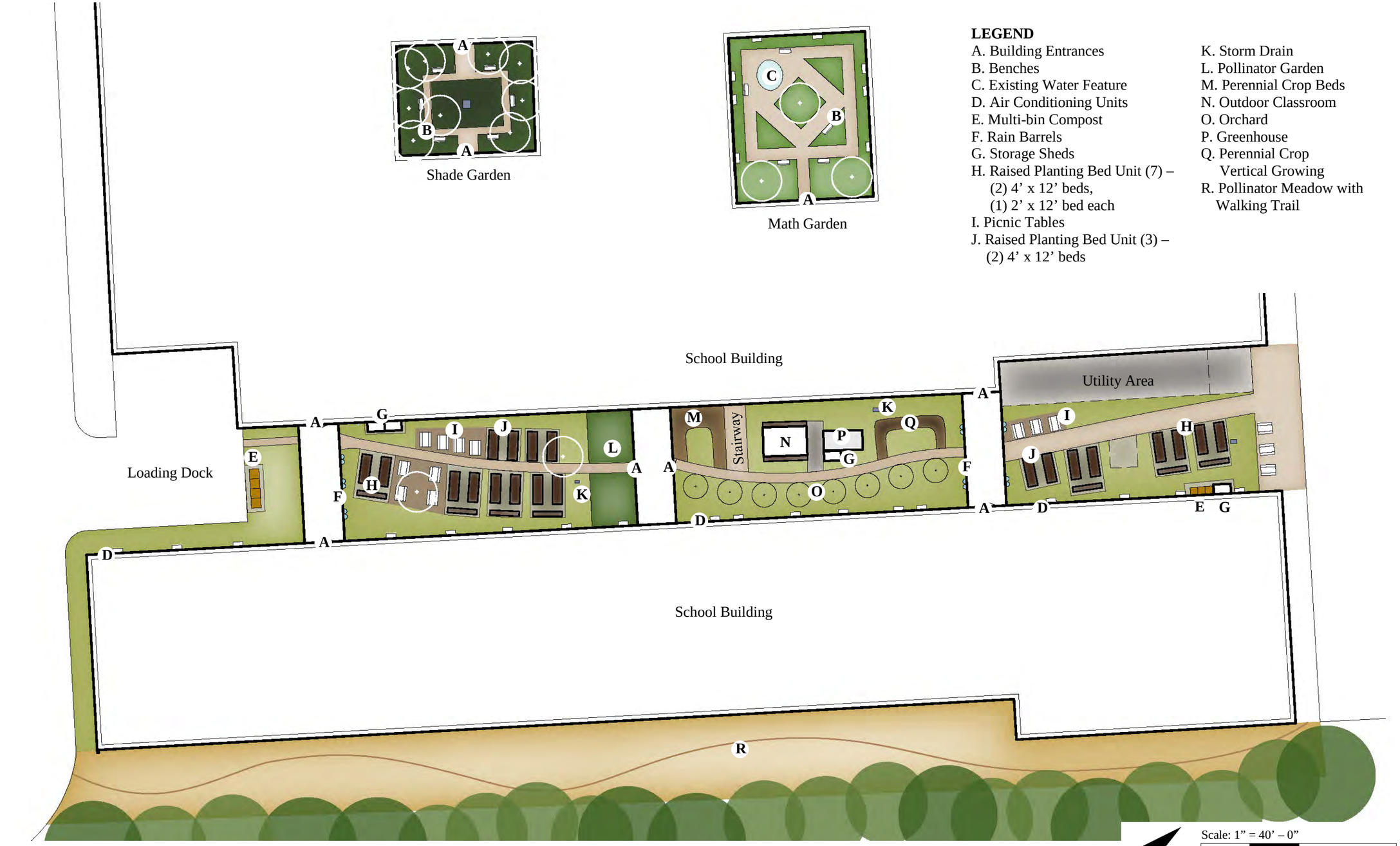


Figure 20. School garden design for Druid Hills Middle School

Design

The design for Druid Hills focused on utilizing all three of the spaces between buildings and the two courtyard areas to make the most of the underutilized spaces. Before implementing the design for the site, a shade study was completed to make sure these spaces would be appropriate for growing. These shade studies are included in Appendix D. Discussion of each of the design principles defined in Chapter 6 utilized for the design for Druid Hills Middle School are detailed below.

1. Location – The gardens are located in five spaces, all surrounded by the school buildings, providing easy access to the learning spaces. The garden areas are directly outside multiple school building entrances.
2. Zones – With the unique location of the gardens between school buildings, the zone system is not implemented; instead uses were dispersed throughout the spaces to distribute garden access equitably.
3. Space – Since the gardens are divided into five separate spaces, it is easy for multiple users to access the garden spaces at the same time. Each of the garden spaces between the two school wings could easily accommodate at least two classes at one time, since the spaces are so large and have multiple bed sections or activity areas in each. Figure 21 shows a rendering of the proposed garden space in the North garden area.

Figure 21. Perspective of North garden area

4. Assign spaces – The raised beds are designed in units, making it possible to designate one unit per grade level or class team.
5. Paths and aisles – The sidewalks, except in the math courtyard, are all existing and range in width from 3-6’ wide. The math courtyard has five-foot sidewalks. The access spaces between the raised beds are all four feet wide.
6. Accessible – The areas around the raised planters can be laid with pavers or a combination of pavers and gravel. The raised beds with pavers would be fully accessible by wheelchair. Both the outdoor classroom and greenhouse have sidewalk access, allowing access by all student users.
7. Soil – Since the majority of the beds are raised for this school garden site, soil building is not a high priority. The areas that might require soil building include the small orchard and the perennial crop beds.

8. Water – All the garden areas have access to hose connections. Irrigation should be considered for at least the perennial crops and orchard.
9. Water harvesting – The gardens between the school buildings include rain barrels to harvest and store supplemental water for the gardens. This water harvesting system increases the number of rain barrels from the existing six to 14 barrels.
10. Seating – Numerous picnic tables are scattered in the garden spaces, the courtyards have a several benches, and there is an outdoor classroom, allowing plenty of seating for students in the gardens for both classes and leisure.
11. Outdoor classroom – A covered outdoor classroom area is located next to the greenhouse in the center area between the school buildings. Figure 22 is a perspective rendering showing the outdoor classroom space and the greenhouse.

Figure 22. Perspective of outdoor classroom and greenhouse

12. Shade – The outdoor classroom is covered; shade is also cast by trees and buildings.
13. Storage – The three edible garden spaces all have sheds to store tools and supplies for the gardens.
14. Compost – A large multi-bin compost system is located in the northern-most garden space, near the loading dock and dumpsters. A smaller compost bin system is also included in the southern-most garden space.
15. Greenhouse – An eight foot by 16-foot greenhouse is located in the central garden space between buildings on an existing concrete slab. This will allow extended garden use, and with the central location should be easily accessible to all classes in the school.
16. Bed styles – The edible gardens are mostly raised beds. The perennial crop beds, and the courtyard gardens are all in ground beds.
17. Raised beds – The larger of the raised garden beds are four feet wide and 12 feet long. The smaller raised beds are two feet wide and 12 feet long. All the beds are rectangular, to make them easy to build with standard lumber or concrete blocks. Ideally, the beds should be 18 to 24 inches in height to allow easy access without fully bending over, and to allow easier wheelchair access.
18. Variety of plants – With the variety of spaces and garden styles, there is the opportunity to grow a large variety of plants.
19. Perennial crops – The site includes two perennial crop beds, herb gardens, and a small orchard.

20. Ornamental plantings – The two courtyards are all ornamental plantings themed to allow for relaxation and additional curriculum incorporation. The shade garden has quiet areas for students to sit and relax, while the math garden was designed to be used for lessons on geometry.
21. Year-round use – The greenhouse, perennial crops, and covered outdoor classroom space allows for the garden spaces to be utilized most of the school year.
22. Specialty plantings – The garden areas include pollinator areas, a shade garden, and a math themed garden space to allow for connection to more curriculum topics. Figure 23 shows a rendering of the math garden courtyard. The math garden uses simple, common shapes to provide an opportunity for basic geometry lessons.

Figure 23. Perspective of math garden

23. Vertical gardening – Trellises can be added to any of the raised beds to allow for vertical growing. One of the perennial crop areas is designed to accommodate grape vines or other vining crops by incorporating trellises.
24. Natural forms – Natural forms were not utilized in this school garden design due to the space limitations and the desired design goals.
25. Multifunctional – Each of the garden spaces is designed to allow for multiple functions at once: gardening, compost, seating for lessons, seating for relaxation, rain water harvesting, math studies, writing and reading, or just general outdoor class gathering.
26. Maintenance – Adding gravel or paving around the raised garden beds makes mowing and turf maintenance easier for the school maintenance contractor. The edible garden beds would all be maintained by users, but the central location makes the gardens easy to access for daily maintenance. Irrigation, especially for perennial crop areas, would help to alleviate some of the maintenance demands of the garden.
27. Benefits – The variety of the spaces and functions of the gardens and elements keep them interactive and relaxing, while fostering the ability to incorporate more experiential learning into the school culture.
28. Curriculum – The gardens include three edible gardening areas, a shade garden, and a math themed garden. These spaces can relate to numerous curriculum elements in the school including sciences, nutrition, math, language arts (such as reading and writing), and even art.
29. Rules – The rules for the garden should be defined by the school.

30. Enclosure – The only spaces that are completely enclosed are the two interior courtyards. Since security has not been an issue in the past the other garden spaces were designed without any enclosures.
31. Security – Security needs for the garden should be assessed by the school to see if additional enclosure or cameras may be needed.

Hilsman Middle School

Context

Hilsman Middle School was one of the case study sites in Athens, GA, Figure 24 provides an overview of the school site. The old school garden and building have been demolished, and a new building is currently being built. School administrators would like to include gardens with the new school building to replace the ones that were removed due to construction (Tolbert 2018). The new building plans were provided by the Clarke County School District. The conceptual school garden design for Hilsman will be based off these new building plans. The new school site includes two large courtyard areas and an open space southwest of the activity field behind the school. There are plans to include a greenhouse out in this area by the activity field. These three locations on the site are relatively flat. The size of the usable garden space is limited by slopes to the south and west. Figure 25 shows a plan view of the proposed school garden design for Hilsman Middle School based on the findings from Chapter 6. In preparation for the design of the gardens, an attempt at finding Clarke County School District design standards was made without success.

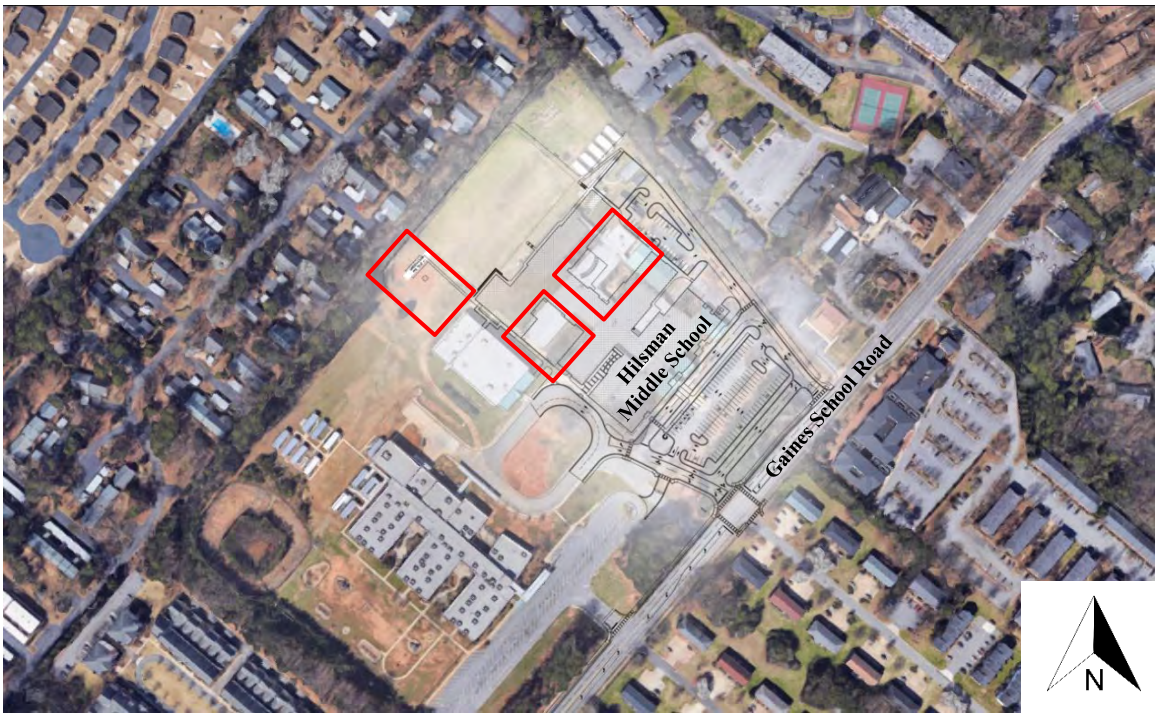


Figure 24. Overview of Hilsman Middle School site

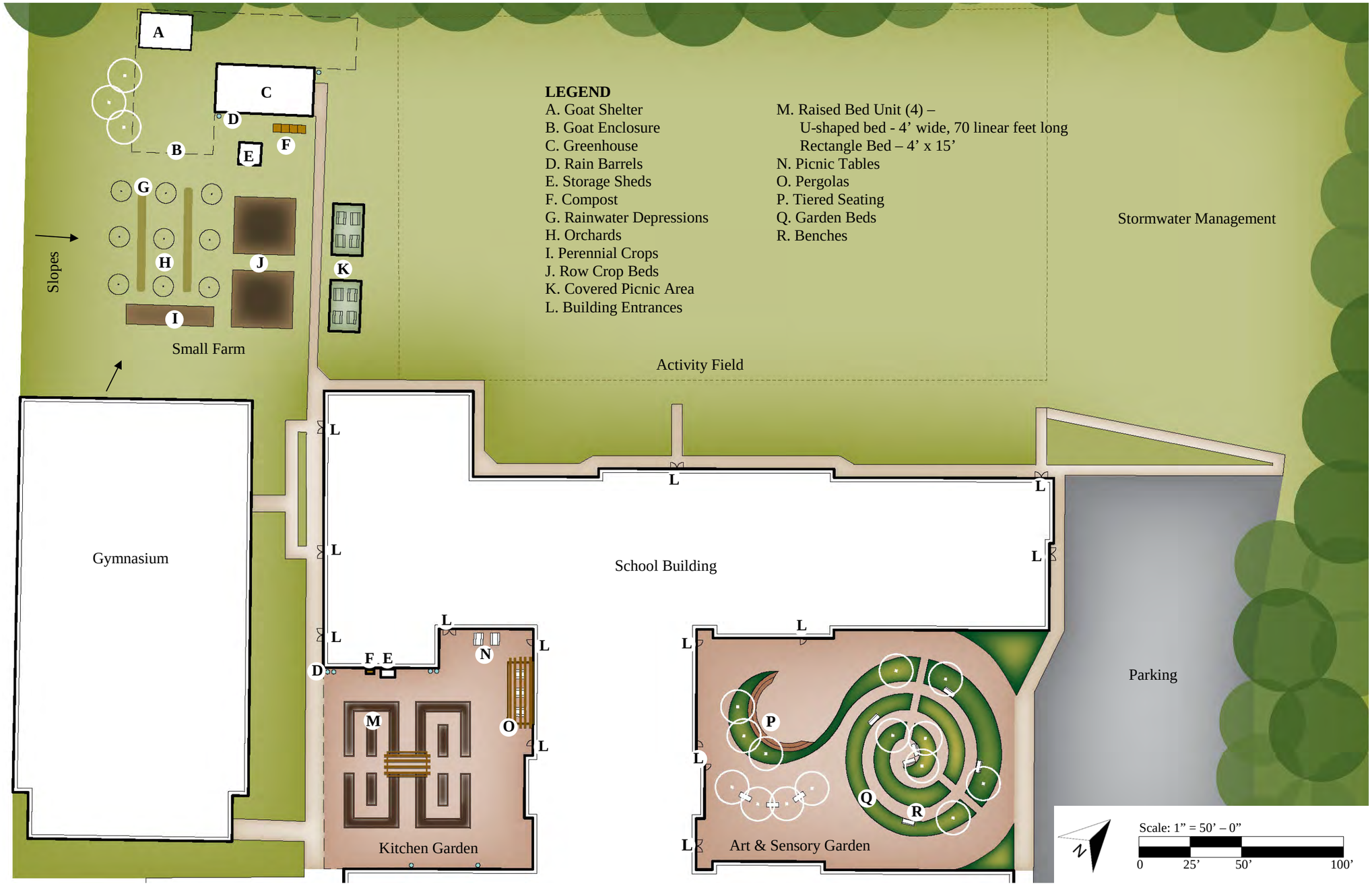


Figure 25. School garden design for Hilsman Middle School

Design

The design for the new school garden at Hilsman Middle School aims to efficiently utilize the available spaces, both the courtyards and the larger open space with the greenhouse behind the school. A shade study was completed on the new building layout to determine the exposure of the two courtyard areas. The garden space in the back of the site is open and receives full sun. These shade studies are included in Appendix D. Below details the application of the design principles to the spaces at the new Hilsman Middle School site.

1. Location – The garden areas in the two courtyards are the closest to classroom access (within a few feet of building entrances), while the larger garden area (small farm), is located further from the building, but still within 60 feet of the nearest entrance, behind the gymnasium and next to the activity field.
2. Zones – Since not all the garden spaces are close to the school building a simplified system of zones was utilized in the design. The courtyards act as zone one in this school's system; they are gardens that can be used every day and easy to access. The vegetable garden (kitchen garden) will require daily care. Zone two is the area near the greenhouse, or the small farm area. These spaces would be visited less frequently because they are further from the school building and should be planted with more perennial crops to require less maintenance.
3. Space – Since the gardens are broken into three distinct areas, it would be easy for multiple classes to use the gardens at once. Even the courtyard with the kitchen style vegetable garden has four distinct spaces that allow for multiple classes to use each at the same time.

4. Assign spaces – In this model, the gardens are designed to be used more communally by the entire school. The distinct raised bed units in the kitchen garden could be assigned, one to each grade level and one for special education classes or could be divided in some other way as defined by the school.
5. Paths and aisles – Sidewalks are all from the existing school plan and range from three to four feet wide. Access spaces in the kitchen garden are eight feet wide for the main paths and six feet wide for the horseshoe shaped areas. The art and sensory garden incorporate paths that are four to six feet wide. The small farm area is a large open space with access lanes eight or more feet wide.
6. Accessible – Both of the courtyard gardens are fully accessible, paved, and with little grade change. For the farm, the only area fully accessible is the greenhouse.
7. Soil – Building up the soil in the small farm area would be essential to the long-term success of the area, especially after the site construction.
8. Water – Though the plans received for the site do not include location of water sources, hose connections should be included in each of the garden spaces. The small farm should incorporate irrigation in the beds to decrease maintenance demands.
9. Water harvesting – Rain barrels could be incorporated into the kitchen garden area and the small farm, to harvest and store additional water for the gardens. Also, the orchard and perennial crop areas of the small farm should use depressions between crops to allow rain water to slow and infiltrate into the soil.
10. Seating – Picnic tables are used for seating in the kitchen garden and the small farm, while the art and sensory garden has tiered seating and benches.

11. Outdoor classroom – Though there is not a designated outdoor classroom area in this design, the covered picnic tables at the small farm and the tiered seating in the art and sensory garden can both serve as outdoor classroom areas.
12. Shade – Shade in the gardens is provided by trees, vine covered arbors, a pergola, and the buildings themselves.
13. Storage – The small farm has a large storage shed and plenty of open space for bulk material storage. The kitchen garden includes a small shed to house the tools and materials needed for that garden space.
14. Compost – The small farm has a large multi-bin compost area near the greenhouse. The kitchen garden includes a small barrel compost unit to avoid unfavorable odors so close to the classrooms.
15. Greenhouse – The greenhouse is sited based on the existing construction plans; it is a 24 foot by 48-foot structure.
16. Bed styles – There are numerous bed styles used throughout the gardens, both raised and ground beds, ornamental, and edible. Rectilinear forms were used in the kitchen garden and small farm to provide a simple, easy to use layout that complimented the rectangular building forms. The art and sensory garden was created with more curvilinear forms to provide a relaxing experience and connect to the art curriculum.
17. Raised beds – The raised beds used in the kitchen garden are all four feet wide and surrounded by pathways to allow easy access for maintenance. These beds are also 24 inches tall, with six-inch brick walls, allowing for students to sit along

the bed edges to tend the plants. Figure 26 shows the raised beds in the kitchen garden.

Figure 26. Perspective of kitchen garden area.

18. Variety of plants – The gardens spaces at Hilsman are incorporated into three distinct areas of the campus with a large amount of space to use. This allows for a wide variety of plants to be planted in the gardens.
19. Perennial crops – The small farm area incorporates an orchard and perennial crop areas. Figure 27 is a rendering of the proposed small farm space with the perennial crops.

Figure 27. Perspective of small farm area.

20. Ornamental plantings – The art and sensory garden is an ornamental landscape which is not focused on food production. Shade trees were incorporated into garden areas as needed to provide shelter from the sun for users and goats.
21. Year-round use – With the incorporation of the perennial crops and the greenhouse, as well as the art and sensory garden, all of the garden spaces can be used year-round.
22. Specialty plantings – The art and sensory garden space is a specialty garden area. The garden has direct access to the art classrooms and the special education classrooms. The concept of the garden is to provide stimulation and inspiration to student users. Plant material should include a variety of colors and textures and incorporate scents, creating an interactive sensory experience for all users. Figure 28 shows a rendering of the art and sensory garden space.

Figure 28. Perspective of art and sensory garden area.

23. Vertical gardening – Trellises could be incorporated into sections of the raised beds to allow for growing climbing crops. The covered seating at the small farm is planted with vining and climbing plants, both perennial and annual crops.
24. Natural forms – The art and sensory garden is a large area following a spiral form. The design is based on an S-curve, a common design element incorporated into artwork. One section of the garden spirals into a central seating area. This spiral design allows users to access and interact more with the plantings. The raised bed sections in the kitchen garden are designed like a modified keyhole garden from permaculture to maximize growing space while still allowing for easy garden access. The orchard in the small farm uses a net layout for ease of maintenance.
25. Multifunctional – The covered seating at the small farm serves multiple purposes: seating, classroom, shade, and production space. The walls for the raised beds not

only provide planting space, but also provide seating space for users. The art and sensory garden serves as a multipurpose educational space as well as a relaxation space for students and faculty.

26. Maintenance – The garden areas were located using zones, with maintenance in mind, keeping areas that require more frequent maintenance like the kitchen garden closer to the building for daily access. Also, the incorporation of irrigation in the small farm area would greatly reduce the daily maintenance demands of students and teachers for that section of the garden. The art and sensory garden beds should be irrigated as well to reduce the maintenance demands for the school landscape contractor.
27. Benefits – The design provides a variety of interactive areas to allow for experiential learning and all the benefits described in Chapter 2. The gardens have active spaces and passive relaxing spaces for users to enjoy.
28. Curriculum – With the variety of garden spaces and uses, the school gardens at Hilsman can accommodate a variety of curriculum standards. The edible gardens fit into science, agriculture, family and consumer sciences, health, and special education curriculums. The art and sensory garden can be used for art, special education, or even language classes.
29. Rules – Rules for the garden spaces should be developed by the school to best suit its needs.
30. Enclosure – In the current construction plans, the kitchen garden area is fenced on its one open side. The proposed kitchen garden design allows for the area to be

fenced or remain open, depending on the needs and desires of the school. The only other area on the site that is fenced is the goat pen.

31. Security – The garden areas should be incorporated into the campus security plan. The spaces may require fencing or cameras to meet the security needs of the site.

Discussion

After testing the guidelines developed it is clear that several of the guidelines and recommendations could be applied to almost any school garden design. These include location, space, paths, accessibility, water, seating, shade, storage, compost, and vertical gardening. The test gardens both included elements of all the guidelines listed above. The findings of this research led to the determination that these guidelines are the most essential basics to school garden design. As discussed in previous chapters, location and thoughtful layout of the basic garden components is important to the usability and function of the garden spaces for classes.

Some of the guidelines would be more difficult to apply universally to all schools because they either may not fit in the space available, or because additional planning beyond the design is needed to complete the recommendation. These recommendations include zones, assigning spaces, water harvesting, outdoor classrooms, greenhouses, bed styles, diverse variety of plants, perennial crops, ornamental plantings, specialty gardens, natural forms, and enclosure. Other guidelines that would be more difficult to apply universally are due to two factors: either they aren't physically represented, or they require additional planning on the school's part beyond design. These include year-round use, multifunction, maintenance, benefits, curriculum, soil building, rules, and security.

These guidelines can influence the design of the garden spaces but ultimately, they rely on the implementation by the school to be successfully met. For example, the design could recommend soil building techniques for an area, but in the end the school has the choice on how it will proceed and how quickly it may want to get the garden growing.

Using the guidelines in the test designs shows how they can be applied to two different school sites. The list of guidelines and recommendations developed through this research is not a design checklist for school gardens but more of a road map to help decide how to best layout the space and components to improve function and usability of a school garden. These guidelines look at the basics of school garden design; further research may supplement these for guidelines in other regions, climates, or design intentions.

CHAPTER 8

Conclusion

Overview of Research

This research study strove to provide guidelines for garden design specifically for the school setting. To complete this task, the research began by investigating the history of school gardens and outdoor learning. Gardening and outdoor learning have roots in experiential learning methods that have been used to educate children long before educational theorists like John Dewey and David Kolb wrote about these learning methods. Many people can easily make the connection that humans, even adults, learn from experience. It is through this understanding, compounded with childhood nutrition concerns and children's disconnection with nature in a growing digital age, that has fueled the current school garden movement. School gardens are a way to reconnect students with the natural world, food systems, and the impacts that humans have on these systems. Several research studies demonstrate the benefits of school garden learning, but limited resources on how to design school gardens are currently available. This research has sought to begin filling this gap in school garden research.

The investigation into existing school garden programs at six different school sites provided insight on the uses and demands of a school garden. Comparing the various layouts and footprints of the garden spaces illuminated some of the design techniques that are already in use in school garden spaces. The questionnaires built upon this by providing insight on what layout and design techniques have worked, what did not

work, and what the gardens lack. It is from the case studies that definitions of the design guidelines and recommendations for school gardens were developed.

The exploration into other garden design theories was needed to provide design solutions to current problems in school gardens and to expand the educational opportunities in the garden. The findings supported many of the same design recommendation findings from the case studies. The theory investigation also provided some additional design recommendations that could help reduce maintenance, increase ease of use, and even expand learning opportunities in school gardens.

The final guidelines and recommendations outlined in Chapter 6 were a synthesis of the case study findings and theory research. This easy-to-reference guide to school garden design could be used by anyone wanting to design a school garden space. Just like other garden design typologies, school gardens have their own unique set of demands, and the guidelines this research has defined help to explain ways to address some of these demands through design. School gardens in general need to be easy to access, spacious enough for classes of students, simple to maintain, while providing diverse opportunities for learning.

As a way to test the validity of the guidelines defined in Chapter 6, this research applied the guidelines to the design of two school garden sites. This made it clear that some of the guideline recommendations go beyond site design and that a successful school garden should have well-planned plantings and related curricula. The sites used for the application of the guidelines were both large and provided numerous garden spaces. The guidelines and recommendations used in the application may not all apply to

smaller sites. Every school site will have its own set of limitations; the guidelines are intended to help designers optimize the spaces available.

Topics for Future Research

Additional design research could be completed for schools in other settings (rural or urban) and geographic regions or focus on incorporating more non-edible gardens into the school garden learning environment. Future research should investigate the viewpoint of students and the design of school gardens.

As this research has progressed, it became apparent that school gardens face a tremendous number of obstacles to success beyond design. At this time, the most pressing research needed for school gardens is how to support them. This support includes funding, resources, training, lesson planning, and maintenance. Additional research could also focus on developing more strategies for all-season use, how to better involve the whole school and the community, how to better incorporate gardens into diverse curricula, and how to address maintenance during school breaks.

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APPENDICES

Appendix A Questionnaires

Recruitment Email

Re: School Gardens Research Study Questionnaire

Dear (Middle School) Faculty,

I am a graduate student at University of Georgia working under the direction of Shelley Cannady. I would like to invite you to participate in a short questionnaire about school gardens in educational institutions. This study is looking to help define some guidelines on designing gardens for education. Attached is a consent letter for the questionnaire that contains additional information about the study. The questionnaire should not take more than 15-20 minutes and is voluntary. The link to the online questionnaire is provided below.

This questionnaire is open for responses from today, DATE until DATE.

If you would like any additional information about this study, feel free to contact me at (970) 560-6074, or by email at erin.mcdonald25@uga.edu.

Thank you for your consideration.

Sincerely,

Keely McDonald
Master of Landscape Architecture Candidate 2019

Please click the link below to access the online questionnaire. As long as you are accessing from the same computer you can return to the questionnaire as many times as you want before submission via the below link.
https://ugeorgia.ca1.qualtrics.com/jfe/form/SV_4JiIzc1upzK9ZSR

Consent Letter

DATE

Dear Faculty member at (Middle School):

I am a graduate student under the direction of professor Shelley Cannady in College of Environment and Design at The University of Georgia. I invite you to participate in a research study entitled Growing a Green Generation: Designing Educational Gardens for Schools. The purpose of this study is to provide guidance on school garden design layout and planning.

Your participation will involve answering a few general questions about the school gardens and should only take about 15-20 minutes. Your involvement in the study is voluntary, and you may choose not to participate or to stop at any time without penalty or loss of benefits to which you are otherwise entitled. If you decide to withdraw from the study, the information that cannot be identified as ours will be kept as part of the study and may continue to be analyzed, unless you make a written request to remove, return, or to destroy the information.

This study is an online questionnaire that will not be collecting personal information beyond grade level taught and subject area taught, names and additional personal information is not required for this study. Please keep in mind the inherent risk of confidentiality when transferring data over the internet. Potential IP data may end up associated with the questionnaire digital responses, this information will be destroyed immediately after the questionnaire closes, and any remaining identifiable information will be destroyed after the study is concluded in May 2019. Any identifiable data collected in the study will be limited to myself and my major professor, Shelley Cannady. The results of the research study may be published, but your name or any identifying information will not be used. In fact, the published results will be presented in summary form only.

The findings from this project may provide information on design considerations for gardens specifically designated for educational use at schools. There are no known risks or discomforts associated with this research.

If you have any questions about this research project, please feel free to call me at (970) 560-6074 or send an e-mail to erin.mcdonald25@uga.edu, or contact Shelley Cannady at (706) 542-4868 or scannady@uga.edu. Questions or concerns about your rights as a research participant should be directed to the Institutional Review Board (IRB) Chairperson at 706.542.3199 or irb@uga.edu.

By completing and returning this questionnaire, you are agreeing to participate in the above described research project.

Thank you for your consideration! Please keep this letter for your records.

Sincerely,

Keely McDonald

Master of Landscape Architecture Candidate 2019

Questionnaire

Growing a Green Generation: Designing Educational Gardens for Schools

Please see questions below.

Q1. What grade level do you teach?

6th
7th
8th
Other

Q2. What subject do you teach?

Q3. What is the average size of your class?

10-15 Students
15-20 Students
20-25 Students
25-30 Students
30 + Students

Q4. How many times a week do you use the school gardens in lessons?

0-2
3-5
6 or more

Q5. Could you provide a brief description of common lesson topics you teach in the school gardens? List up to 3 topics.

Topic 1
Topic 2
Topic 3

Q6. What are some of the features that you <u>like</u> about the school gardens as a teaching tool? Briefly list up to 5 features.

1
2
3
4
5

Q7. What are some of the features that you <u>dislike</u> about the school gardens as a teaching tool? Briefly list up to 5 features.

1
2
3
4
5

Q8. In terms of design, layout, and location, what would make you use the school gardens more frequently in lessons? Briefly list up to 3 items.

1
2
3

Q9. What improvements or changes would you like to see in the school garden? Briefly list up to 3 items.

1
2
3

Q10. Please feel free to include any additional comments about the design and layout of the school gardens.

Appendix B Questionnaire Responses

School District	School	Q1: What grade level do you teach?	Q2: What subject do you teach?	Q3: What is the average size of your class?	Q4: How many times a week do you use the school gardens in lessons?	Q5: List 3 common lesson topics taught in the school garden	Q6: List 5 features you like about the school garden	Q7: List 5 features you dislike about the school garden	Q8: List up to 3 items that would make you want to use the garden more frequently	Q9: What improvements or changes would you like to see in the school garden?	Q10: Additional Comments
Dekalb	Chamblee Middle	7th	Biology	20-25 students	0-2	Insects and Pollinators Plant and Seed Identification Garden maintenance and planting	Hands on activity Expose students to outside environment Expose students to how food grows Expose to ecosystems and biomes Teach basic gardening	Large class sizes limits individual time with students Size of garden is too small for classes and production Regular maintenance is difficult to incorporate into pacing chart Cost for plants/supplies limited summer maintenance is challenging	More seating and work areas for students Larger garden beds or areas for planting lack of sunlight with trees shading	Automatic irrigation or drip irrigation using rain water Solution for numerous ant piles Larger compost bin	Poor location chosen, and the sunny areas not used for the planting beds, regular maintenance is an ongoing issue and funding for anything associated with the garden is time-consuming
Dekalb	Chamblee Middle	All grades	Math, Science, Social Skills	10-15 students	0-2	Soil content and make up Plant parts and photosynthesis Ecological impact and chemical options	Hands on real-world models boost motivation and synthesis of concepts Build life skills Allows for outdoor lessons Students move around, which lowers stress and aids class management Raises awareness of the costs and benefits of urban farming	Seasonally inaccessible or less usable Can be dirty, additional time for clean up Usually not accessible by more than one class at a time	Clear system for clean up before returning indoors Use of more perennial plants, at least one plant that grows and blooms for each season Having more tools to gather data from the garden	Clear system for clean up before returning indoors Growing plants that can be studies year round with seasonal blooms Provide more tools to gather data	
Dekalb	Chamblee Middle	7th and 8th	English Language Arts	20-25 students	0-2	none	Interactive Creates connection between students and the Earth Teaches responsibility Inspiration	Could be larger Requires good weather Needs constant care	More variety of plants Weather proof plant labels One central location (mini-library) to access information about gardens/ related subjects	More variety Seasonal plants Fruit trees	There is a large opened space between, if they added inviting landscaping around the garden they could inspire students to want to engage in the garden- perhaps add a quite reflection spot within the garden, with places to sit(as a ela teacher would love a calm, nature spot for students to relax and read/write

Dekalb	Champion Middle	All Grades	Science	20-25 students	0-2	Soil Food webs & pollination Vermi/composting	Real life experience Allows movement for students	Maintaining it year round		Adding a water feature	Our garden layout seems to work for us at the moment
Dekalb	Druid Hills Middle	6th	English Language Arts	20-25 students	0-2	Write haiku or other poetry	Gives students something to describe in writing		More seating or tables for writing	More flowers	Appreciate gardens but currently only use during spring poetry unit
Dekalb	Druid Hills Middle	7th	Math	25-30 students	0-2	Mathematics in nature, common shapes and patterns	relaxed and attractive learning environment	end by parking lot not as aesthetically pleasing	Too small Needs more seating		
DeKalb	Druid Hills Middle	7th	Social Studies	25-30 students	0-2		Self-sufficient commu nity building man the maker qualities great connections to science standards gardening as community service work gardening is hands on		Lucky to have hands on garden on site		Kathy Cochran and her environmental club students have done a great job keeping up the garden and expanding the amount of garden at the school. Garden is accessible to all and reinforces IB motions of community service with our student population.
Dekalb	Druid Hills Middle	All Grades	ESOL Language Arts	25-30 students	0-2		Getting students outside Learning about where food comes from Observing natural beauty	Big school, small garden, difficult to access	Plots for each team		
Dekalb	Druid Hills Middle	6th	Science	25-30 students	0-2	Erosion Seasons	Hands on experience Real world examples	Lack of time			
Dekalb	Druid Hills Middle		Academic Coach				Hands on				Great idea for extending lessons and for students struggling to find something to connect to
Dekalb	Tucker Middle	6th	Math	20-25 students	0-2	We do no have access to the garden					
Dekalb	Tucker Middle	6th	Science	25-30 students	0-2		Easily accessible Provides hands on learning experience Offers real world connections	Feels distance and not a part of school culture	Designated classroom area		

Dekalb	Tucker Middle	Program Coordinator	Technology	30+ students	0-2		Outdoor space Kids can talk without being disruptive to other groups	Not easy to talk to students all at once No space for visual illustration of a concept (chalk/white board) Too hot in the spring/summer	Central space to speak with students Shade More horizontal work space - portable tables	Better control of trash and clean up after classes predefined activities or lessons that teachers/students can do	
Dekalb	Tucker Middle	6th	Science	20-25 students	3-5	Compost formation Aquaponic plant growth Crop selection, growth, and harvest	Growing plants for food and market Staring planting early in a controlled environment Students growing seed plants in a greenhouse to transplant to home Controlling pests and weeds Using 3 sisters planting method	Limited space Distractions Cost Maintenance needs	Handouts Connections to science standards Positive feedback from parents	Additional financial support	The gardens are a great opportunity for students to learn about becoming more self-sufficient growing food. Also understanding the relationships between soil, water, weather, plant growth, pests, and weeds. Building and maintaining tools, aquaponic table, and greenhouse gives hands on experience.
Dekalb	Tucker Middle	All grades	Spanish	25-30 students	0-2						I don't really use the school gardens
Clarke	Clarke Middle	All Grades	Family and Consumer Sciences	20-25 Students	0-2	How to harvest and use Kale Food preservation with bumper crops Seasonal eating, eating food based on availability and seasonality	Students connect with food In age of convenience, garden forces students to see the upsides of sowing more on their own and not relying on others to feed them Alternative classroom space, some students that struggle in traditional classroom thrive in garden Students more willing to try new vegetables if they helped grow it Helps students become more knowledgeable about food	Juggling upkeep with other teaching responsibilities Not all units relate to garden, not used year round Care for weekend and holidays are challenging (CMS has good system but not everyone does)		More content teacher use and involvement	
Clarke	Clarke Middle	7th	English Language Arts	25-30 students	0-2				Not sure how to bring it into our lessons, but open to ideas		

Clarke	Clarke Middle	7th	Science and Social Studies	10-15 students	0-2	Symbiosis Influence of sunlight on living things Nematodes/decomposers in the soil	Convenience Relatable				
Clarke	Clarke Middle	All Grades	LID Functional Academics, Life Skills, CBI	10-15 students	3-5	Planting Plant Care Harvesting and cooking	Variety of life lessons Teaching the entire plant and food cycle Farm to table teaching Convenience Sustainability	Difficult to manage Planning		Irrigation system	
Clarke	Clarke Middle	All Grades	Agriculture	25-30 students	3-5	Garden management Planting Managing produce sales	Local produce available to students Real life business principles Real life issues and problem solving Access to number one industry in GA Opportunity for students who are kinetic learners	Not enough work for all classes to do same thing / equity Student behavior outside Students constantly ask to go outside every class	Increase size	New gloves	
Clarke	Hilsman Middle	8th	English Language Arts	15-20 students	0-2		Different atmosphere Nature for writing inspiration Calming for students		Ease of access Semi-private, limit interruptions Plenty of seating		
Clarke	Hilsman Middle	6th	Social Studies	20-25 students	0-2	Agriculture Importance of agriculture to economy Impact of resources in a country on agriculture	Quiet places Places to take a break from academics	Not enough Not taken care of	Must be visible to entire school Produce something for the school Be placed in many areas around the school		
Clarke	Hilsman Middle	7th	English Language Arts	20-25 students	0-2		Environment Organic foods Soil quality	Not used enough Meals cooked with	More visible More access	Food for teachers	I would like to eat food from them

Clarke	Hilsman Middle	8th	Math	10-15 students	0-2	Pythagorean theorem Solving equations Systems of equations	Live animals Student volunteering Student ownership required Real world problem solving Connecting contents	Connections to curriculum not always easy to make Difficult to deviate from our own pacing guide Unclear when/how it's available to be used Questions about access	Geometrically shaped	more communication about location, accessibility, etc.	
Clarke	Hilsman Middle	All Grades	Art	30+ students	0-2		Collaborative planter painting				
Clarke	Hilsman Middle	All Grades	Family and Consumer Science	25-30 students	6+	Composting Fresh and local foods Vitamins and minerals	Open for viewing by community Close to water source Plenty of space for lots of students to engage Close to composting site Grow a variety of seasonal foods	Distance from building Limited access to tools Hard to manage over the weekend/breaks when students are gone	Proximity to building Teaching area with seating options and shade Accessibility to gloves and tools	Monopolized by Ag program, should be integrated school wide and allow other teachers and classes to invest in it Use produce as means of outreach to community Outdoor classroom setting, can be used on a regular basis	Garden needs to become a more sustainable effort of the school as a whole, cannot simple rely on a few people to keep running. Layout could be more accessible to classes in terms of proximity, and ease of use for people who are less familiar with the layout.
Clarke	Hilsman Middle	8th	English Language Arts	20-25 students	0-2				Provide lesson plans in the content areas	Students help create and set up garden	
Clarke	Hilsman Middle	All	Special Education	10-15 students	0-2	Basics of gardening	Large space with a lot of different plants and animals to interest a variety of students	Location difficult to get to for children in wheelchairs	Closer to building Wheelchair access More training in activities/lessons to do there		
Clarke	Hilsman Middle	7th	Science	25-30 students	0-2	Food chain/ food web/ energy pyramid Human body systems Photosynthesis	Close to school Allows families access to fresh produce at reasonable cost	Need more around the school	Need more around the school		

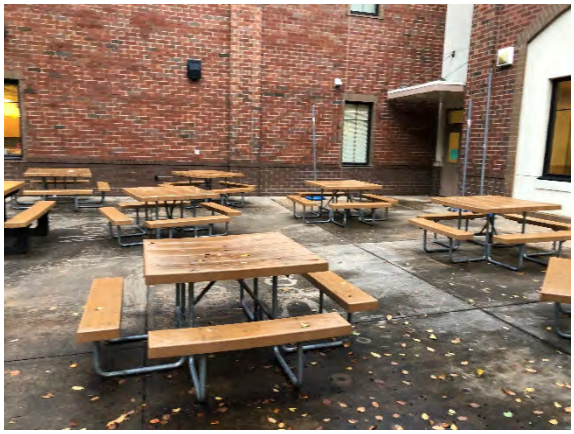
Clarke	Hilsman Middle	7th	Science	30+ students	0-2	Photosynthesis Biodiversity Symbiosis	Proximity to school Variety of plants Hands on experience Raised beds Composting	Incorporate classes other than Ag Science FFA Request student input for crop	More involvement from multiple classes Raised beds Gardening tools easily available	Involve more classes and student Create more types of beds, traditional and raised Have a native plant flower, shrub, tree garden	Visibility and proximity to the school are important
Clarke	Hilsman Middle	All Grades	Orchestra	25-30 students	0-2		Great brain break Student pride in gardens	Far away from building			I don't really use the garden to teach orchestra but I love that we have them.
Clarke	Hilsman Middle	6th	Science	20-25 students	0-2	Soil Soil conservation	Kids use it as a tool to help them understand material Kids get to be able to grow their own food / plants		It would be cool to have an outdoor classroom with the garden that was protected, but we could still go outside and have lessons	Bigger	

Appendix C Site Inventory Photos

Chamblee Middle School





Champion Middle School





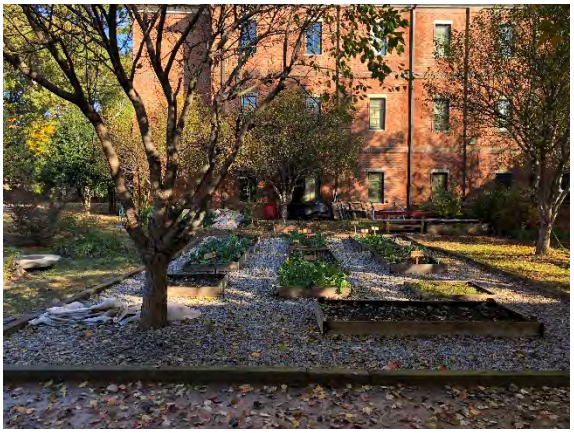

Druid Hills Middle School






Tucker Middle School



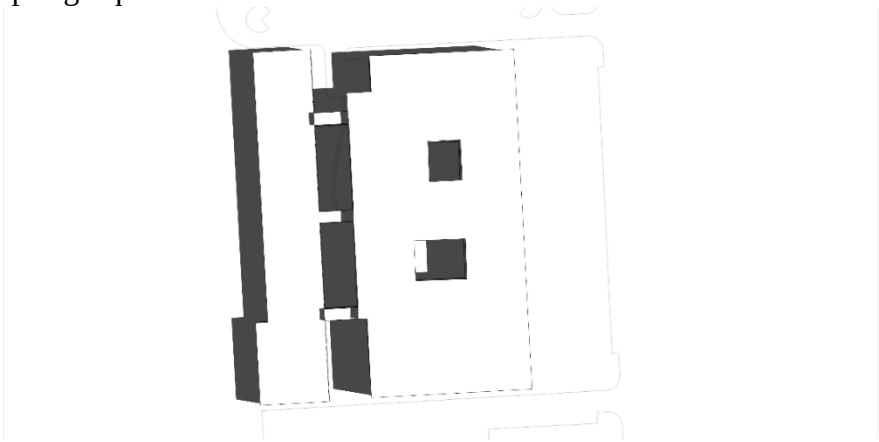



Clarke Middle School

Hilsman Middle School

Appendix D Shade Analysis – Prepared through Trimble SketchUp

Druid Hills Middle School
Spring Equinox – March 20



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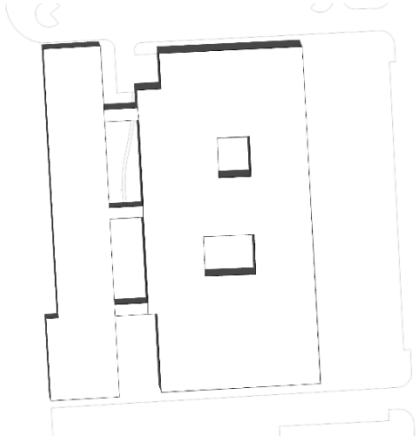

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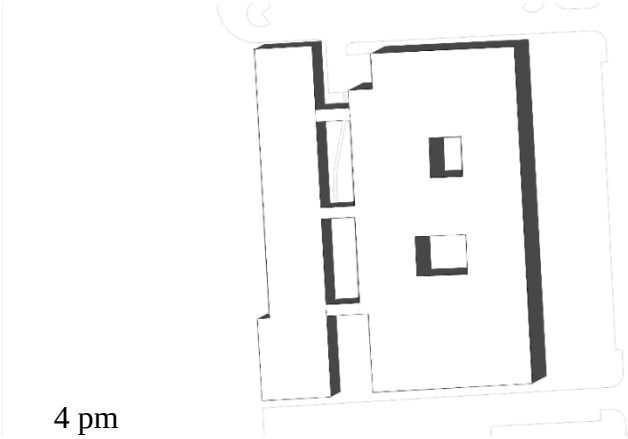

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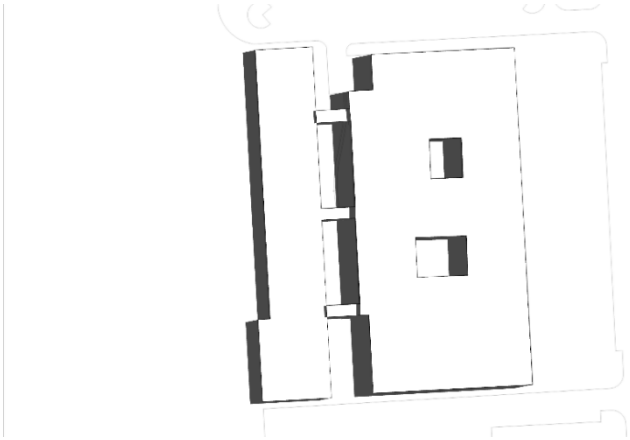
Druid Hills Middle School
Summer Solstice – June 21



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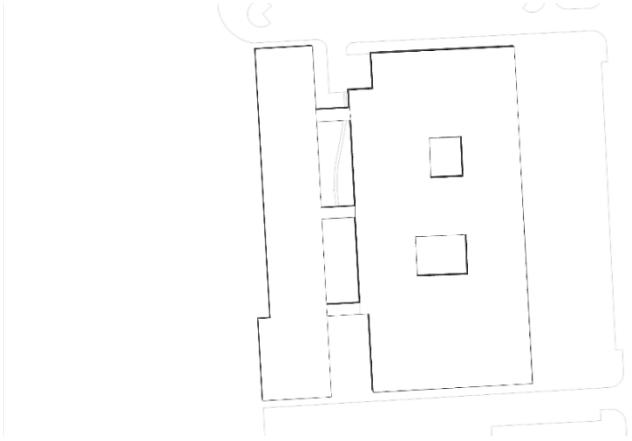

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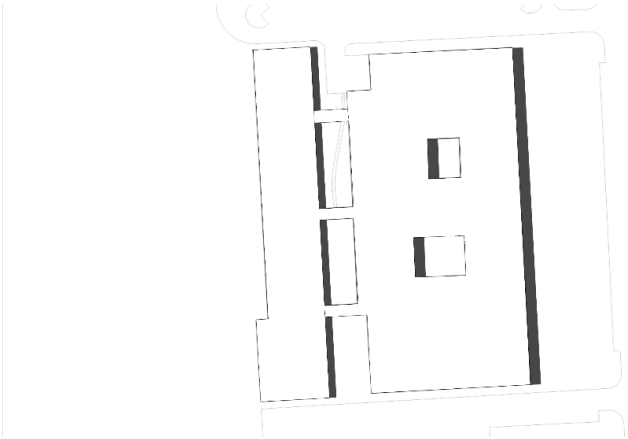

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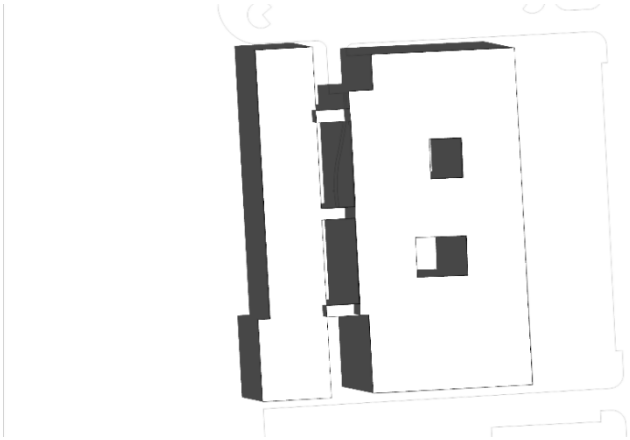
Druid Hills Middle School
Fall Equinox – September 23



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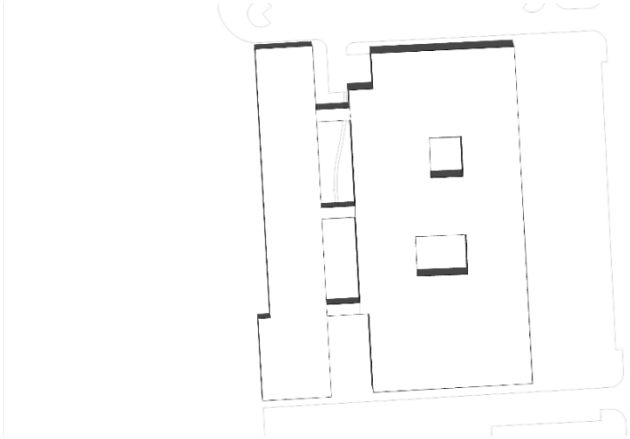

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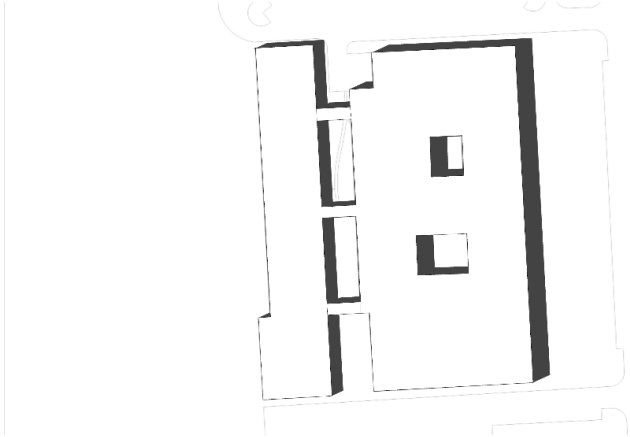

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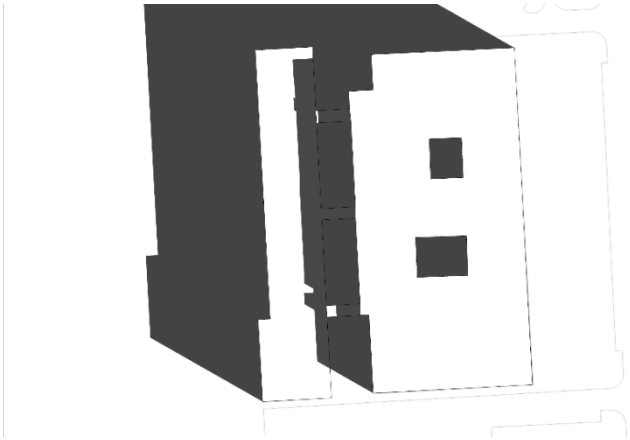
Druid Hills Middle School
Winter Solstice – December 21



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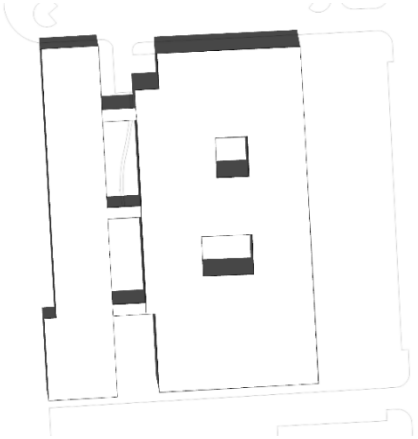

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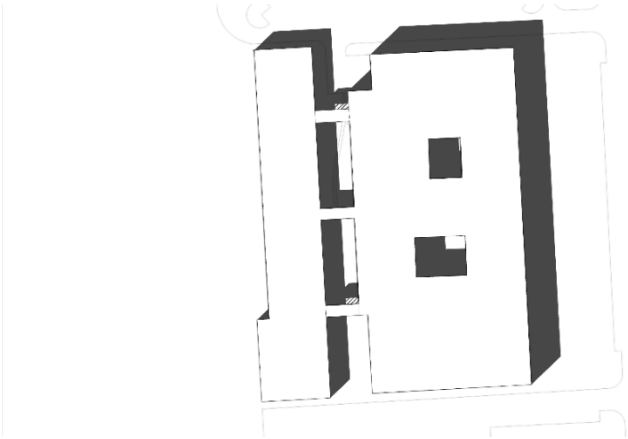

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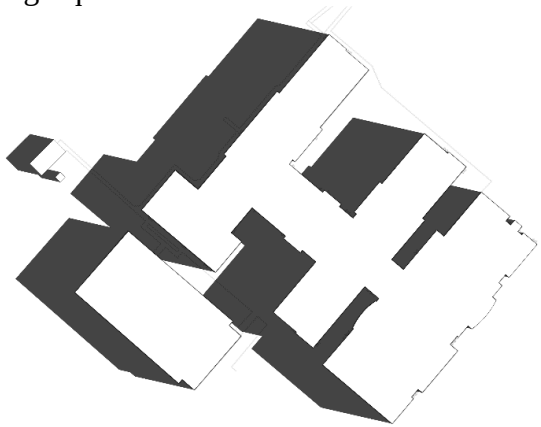
Hilsman Middle School
Spring Equinox – March 20



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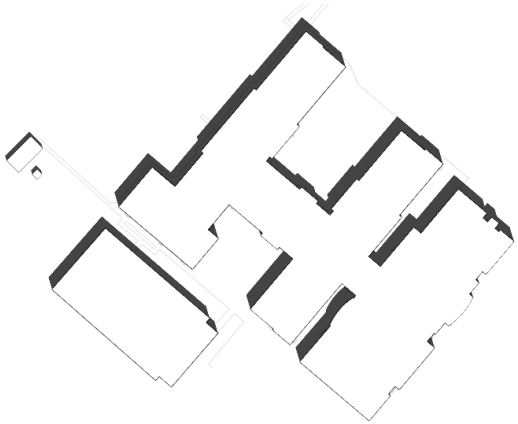

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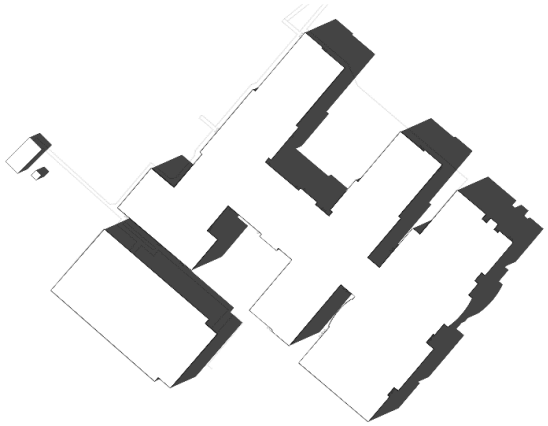

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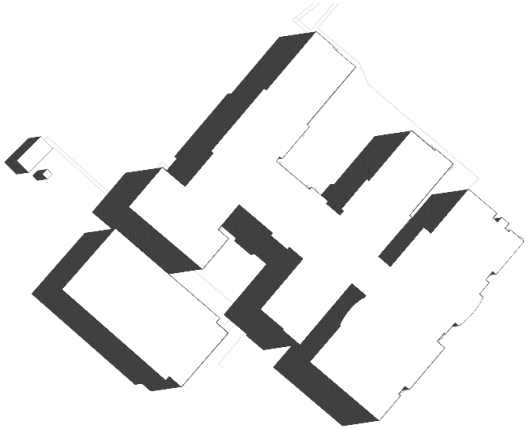
Hilsman Middle School
Summer Solstice – June 21



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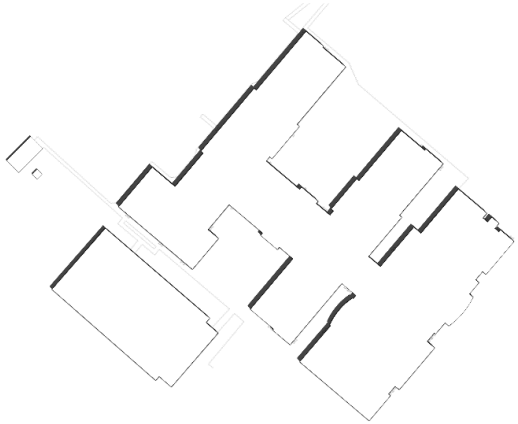

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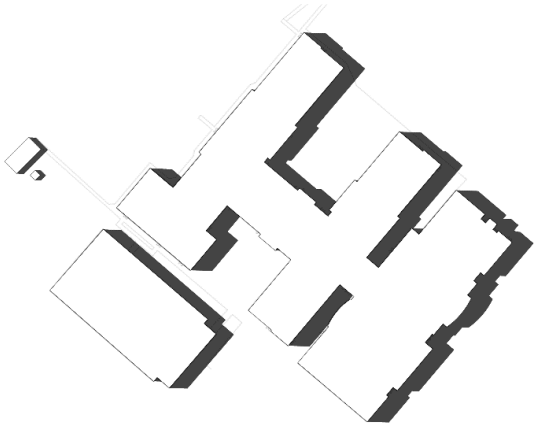
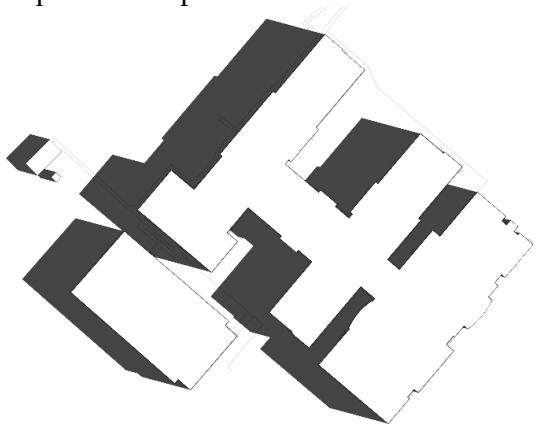
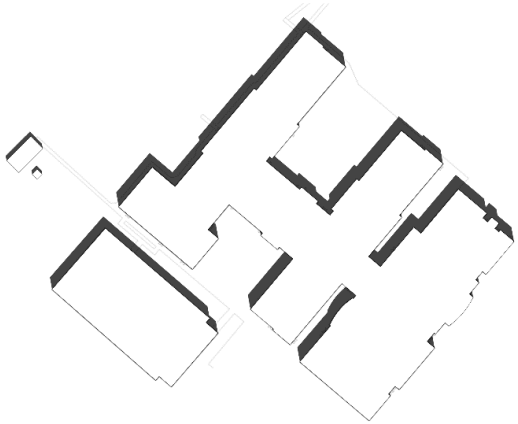


4 pm

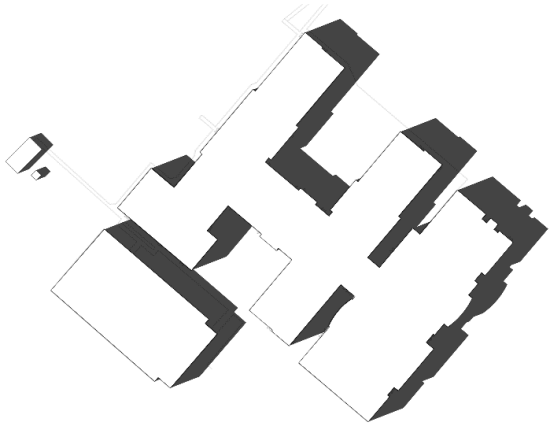
Hilsman Middle School
Fall Equinox – September 23



8 am

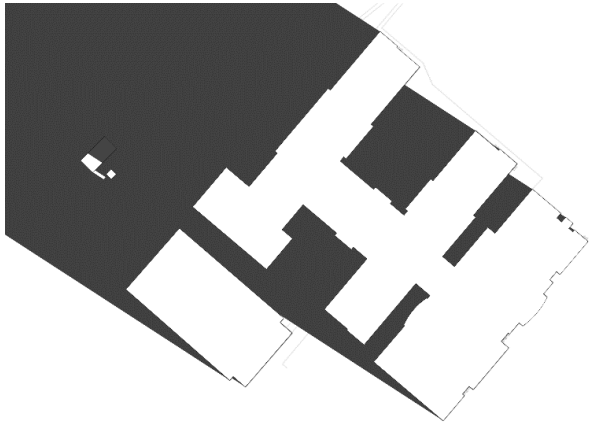


12 pm



4 pm

Hilsman Middle School
Winter Solstice – December 21



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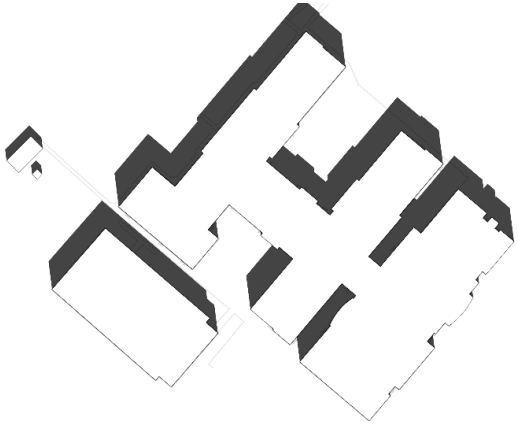
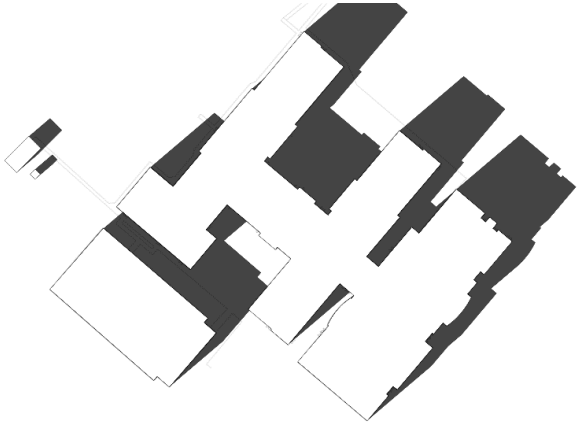


12 pm



4 pm