**Submitted by:**

Jacqueline Forson
Alexander Kant
Jacob Nichols
Alexander O'Neil
Emily Riendeau

**Project advisors:**

Professor Derren Rosbach
Professor Corey Dehner

**Project Sponsors:**

Ms. Mary Conway
Mr. Brian Heath

**Date submitted:**

Monday, July 3, 2017

# Worcester Community Project Center

## Designing An Outdoor Interactive Space That Aids In Cognitive Growth And Development Through Multisensory Stimulation.

# Designing An Outdoor Interactive Space That Aids In Cognitive Growth And Development Through Multisensory Stimulation.

By:
Jacqueline Forson
Alexander Kant
Jacob Nichols
Alexander O'Neil
Emily Riendeau

Submission Date:
July 3, 2017
E Term, Summer 2017

Report Submitted To:

Professor Derren Rosbach
Worcester Polytechnic Institute

## Abstract

This project aimed to create an outdoor interactive environment for residents at Seven Hills Pediatric Center (SHPC). The project worked closely with staff and family members of residents at SHPC to integrate designs into their outdoor areas. Through a human centered engineering design approach, the needs of the residents and requests from the staff and family members were examined to guide design criteria. Ultimately, a sensory garden was developed for SHPC's outdoor area. Landscape architectural designs, multisensory feature recommendations, cost analyses, and a fundraising plan were produced to prepare future integration of a complete sensory garden area. The group constructed vertical gardens for SHPC, as a gateway to the renovations that may come in the future.

## Table of Contents

## List of Figures

## Acknowledgements

We would like to acknowledge the following people for their incredible continued support and assistance during this project:

First, Professor Derren Rosbach and Ms. Corey Dehner, for their guidance, support, and genuine interest in helping us maintain the momentum of this project.

Second, Ms. Ann Mary Pilch, of Tower Hill Botanic Gardens, for her wisdom and willingness to direct us around Tower Hill on multiple occasions, and for being an excellent resource.

Finally, we would like to thank Ms. Mary Conway, Mr. Brian Heath, and the entire Seven Hills Pediatric Center community for providing information, advice, and inspiration to the group. Their passion and excitement for our project helped us strive for excellence. We would like to thank Seven Hills for providing us with such a fantastic learning experience.

## Executive Summary

Over the past several decades, individuals with disabilities have continued to benefit from increasing accommodations of spaces that have resulted from increased advocation and human rights (Smith & Tyler, 2009). To increase access for individuals with disabilities, many locations have been transforming their indoor spaces following universal design principles to allow complete accessibility. Schools and nonprofit organizations have been designing special education curriculums to increase cognitive development for individuals with cognitive disabilities (Erickson-Hall Construction, 2017). Sensory stimulation has been found to be a critical factor in cognitive development, and is utilized heavily in special education classrooms today (Many Benefits of Sensory Gardens, 2017). As more research is conducted on varying disabilities, our knowledge on how to improve the lives of people with disabilities increases. Consequently, we now realize it is imperative to create a universally designed environment, to have both indoor and outdoor spaces that focus on sensory stimulation and accessibility.

Seven Hills Foundation is dedicated to providing integrated clinical, educational, and community based support to children and adults with disabilities and significant life challenges (Seven Hills Foundation, 2017). The Seven Hills Foundation is an affiliation between twelve different locations across the New England area. One of these affiliates, Seven Hills Pediatric Center (SHPC), was the focus of our project. Located in Groton, Massachusetts (see *Figure 1*), SHPC provides long-term, continuous nursing care and short-term respite care to children and young adults, as well as sub-acute care to those above 18 years of age. The interior of this facility had been recently renovated, and received state-of-the-art technology and resources for assisting in cognitive development of the residents. During these renovations, the outdoor areas surrounding this facility did not receive the same level of improvements, and were not kept to the same high standards as the indoor areas. Three main areas outside of SHPC, colloquially known as the Koi Pond area, the Walmart Plaza, and the Gazebo area, had some interactive features,

though these features were not easily accessible to most of the residents, and did little to assist in cognitive development.

Figure 1: Seven Hills Pediatric Center, located in Groton, Massachusetts.

The goal of our project was to assist SHPC by designing an outdoor interactive space that incorporated universal design principles and supports the cognitive growth and development of the residents through multisensory stimulation. To complete this goal, we engaged in a human centered engineering design approach following three key objectives: (1) identifying the physical needs and requested accommodations of clients at Seven Hills Pediatric Center, (2) determining design criteria and developing landscape designs and features, and (3) evaluating and implementing landscape designs and features. Upon completion of this goal, we offered the designs of recreational activities that integrate features that promote development and accommodations for individuals with disabilities.

Before identifying the needs of SHPC, we visited several sensory and healing gardens in order to better understand their purpose. We also conducted surveys and interviews amongst the staff and family members to learn of the residents' needs and desires. We then used our insight of these needs and desires to generate a concrete list of features to implement.

The final outcome of this project was the preliminary stages of renovation of the Gazebo area; a final layout plan, construction of one of our proposed features, and a series of recommendations for future features to be installed. We were successfully able to remove two features that were not easily accessible or otherwise unusable. *Figure 2* depicts the two removed features, a musical installation that most residents could not directly use themselves, and a bridge feature that was too steep for any residents to use. Along with the deconstruction of these two features, we successfully constructed a vertical garden, which contained plants at several different heights to allow all people to be able to enjoy the garden. This specific design, shown in *Figure 3*, features a variety of multisensory plants to stimulate touch, smell, and sight.

Figure 2: Two features that were successfully removed. The feature on the left is a musical installation holding triangles, and was difficult for residents to use independently, as well as being far too loud. The feature on the right is a bridge, that was too steep and dangerous for residents to use.

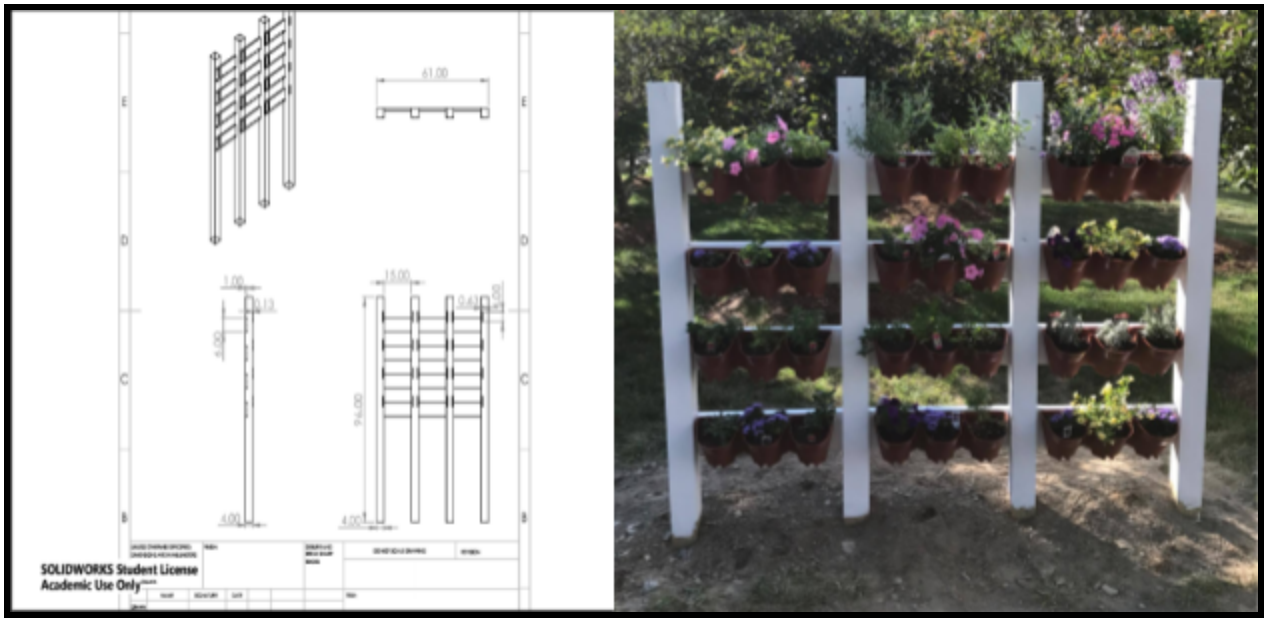



Figure 3: Vertical Garden: The left image shows a three dimensional blueprint of the vertical garden. The right image shows the fully constructed vertical garden at Seven Hills Pediatric Center.

Finally, we were able to produce a three dimensional rendering for the placement of several other features that we recommended. The implementation of these features would improve the overall quality of the outdoor space around the gazebo area. As shown below in *Figure 4*, the final design includes two vertical gardens, two elevated garden beds, a circular fountain, and a pergola for shade. The recommendations we list for Seven Hills Pediatric Center include detailed explanations for our rationale behind each feature we selected, as well as listing ideas, concerns, and notes for purchasing, installation, and maintenance of each feature.

Figure 4: Finalized landscape architectural design for Gazebo area. This design features two vertical gardens, two elevated garden beds, a circular fountain, and a pergola.

Through application of our finalized landscape architectural design, we believe a more accommodating and accessible outdoor environment will become available for residents. Furthermore, we hope our outdoor design promotes increased special education and recreational activities that stimulate cognitive development and growth. We hope that our design successfully meets all of the requirements of the residents and staff of Seven Hills.

## VII. Authorship

**Jacqueline Forson** was responsible for researching and writing the Background, and Results and Findings sections. She also contributed to the writing and editing of the other sections in this report.

**Alexander Kant** was responsible for researching and writing the Introduction and Methodology sections. He also contributed to the editing of the complete report.

**Jacob Nichols** was responsible for researching and writing the Abstract and Methodology.

**Alexander O'Neil** was responsible for researching and writing the Executive Summary, and Designs, and Recommendations sections. He also was involved and in charge of formatting the entire report.

**Emily Riendeau** was responsible for researching and writing the Background, and Results and Findings sections. She also contributed to the writing and editing of the other sections in this report.

# Chapter 1: Introduction

Over the past few decades, studies have shown that individuals with disabilities benefit greatly from having access to a multisensory environment as a means of stimulating cognitive growth (Hussein, 2012). To increase access for individuals with disabilities, many locations have been transforming their outdoor spaces to become more universally accessible, so as to accommodate to more individuals. These places have also renewed their goals so as to improve accommodations in the future to be as accessible as possible (A. Pilch, personal communication, May 17, 2017). However, not all facilities are able to achieve this due to a lack of funding and therefore have outdoor spaces that would benefit from more sensory stimulation and accessibility.

Through continued research reports over the past several years, we now understand the benefits of being outdoors (Marcus, C. C., & Barnes, M., 1995; 1999). Based on the World Health Organization's review of green spaces and health, some examples include improved relaxation, sleep, social capital, and cognitive function (*Urban green spaces and health*, 2016). These additional benefits of an outdoor space have influenced hospitals, like the one at Mass General Hospital in Boston, MA and St. Vincent's Hospital in Worcester, MA, to incorporate healing gardens into their structural design. Additionally, research regarding the effects of outdoor play on development and social skills for individuals with disabilities has redefined the expectations for these individuals (Dorsch et. al, 2016). With increasing reports pointing to improved health, social skills, and cognitive and physical development, outdoor areas are slowly becoming integral parts of special education schools and other facilities that focus on the care and advancement of individuals with disabilities.

A garden environment that includes interactive features and plants that revolve around appealing to many senses, sensory gardens provide a means of advancing physical and mental development to individuals with disabilities (Many Benefits of Sensory Gardens, 2017). Different from a traditional garden or park setting, a sensory garden combines accessibility with a focus on multisensory stimulation and encourages people to touch, smell, and interact with the environment (Many Benefits of Sensory Gardens, 2017). The universal design ideally included

in such gardens allows for people from all walks of life to be able to interact with and enjoy every aspect of the space.

The Seven Hills Foundation is an organization that is dedicated to providing integrated clinical, educational, and community based support to children and adults with disabilities and significant life challenges and is an affiliation between twelve different locations across the New England area (Seven Hills Foundation, 2017). One of these affiliates, the Seven Hills Pediatric Center (SHPC), located in Groton, Massachusetts, was our focus for this project. The interior spaces at SHPC received renovations in 2003, and by comparison the outdoor areas remain underdeveloped.

The goal of our project was to assist Seven Hills Pediatric Center (SHPC) by designing an outdoor space that supports the cognitive growth and development of the residents there through sensory stimulation. SHPC's property had multiple outdoor locations that could have been improved upon, and following our research, we chose to work on the gazebo area because of its accessibility and size. There were some features already present at the Gazebo area prior to our alterations. These features included an auditory feature and a wheelchair bridge. Our plan was to remove these old features and replace them with new ones that would better capture the essence of a sensory garden. To better understand the concept of sensory gardens, we visited existing sensory gardens in the local New England area.

By employing a human centered engineering design approach, we accomplished the goal of designing an outdoor space that will appeal to the senses of the residents. This approach focused our attention on fully understanding the needs of the residents at SHPC and applying them to the space. Once we understood the physical and cognitive needs of the users of the space, we identified relevant design criteria for the interactive areas. We used the criteria to compare existing universal space designs, and worked with SHPC staff and parents to identify the best features for their family members. We incorporated the ideas and perspectives of all the participants, which assisted in the development of the features, designed specifically to serve the needs of SHPC residents.

In our following report, we review the background research, outlined plans, and ultimate final product and recommendations. In Chapter 2, we analyze the complexity of disabilities and the limitations and challenges they pose to individuals, as well as discussing the favored solutions by researchers, caregivers, and educators to best meet the needs of individuals with disabilities. Then in Chapter 3, we discuss the human centered design methods used to complete our project goal. Through the completion of our outlined methods, we discuss in Chapter 4, the findings and results we compiled during our project. Finally in Chapter 5, we review the completed fixture our team installed at SHPC, and also the future implementations we recommend to the facility.

# Chapter 2: Background Information

## Section 2.1: Understanding, Protecting, and Advancing Individuals with Disabilities

The history of advancing human rights and the difficulties experienced through that process is archived in the language that was used to describe individuals in the minority. The terms 'disability' and 'special needs' have varied in meaning throughout history. Before the 1960's Civil Rights Movement in the United States, basic liberties for individuals with disabilities were nonexistent. In the 1970s, cases like the *Pennsylvania Association for Retarded Children v. Commonwealth of Pennsylvania*[1] began appearing before courts arguing for special education access and accommodations for children with disabilities (Smith & Tyler, 2009). As more of these types of court cases were decided in favor of increasing rights for people with disabilities, Congress began writing laws to address the needs of people with disabilities.

Today, various sections of laws provide protection to many of the 1.1 billion individuals with disabilities in the world with basic rights to education, health, employment, and transportation accommodations and services. In the United States, laws like: *Section 504 of the Rehabilitation Act of 1973*, the *Americans with Disabilities Act of 1990*, the *Assistive Technology Act of 1998*, and the *No Child Left Behind Act of 2002,* have been enacted to address the need for disability services. Globally, a 2008 convention at the United Nations resulted in 173 states reconstituting basic human rights that should be upheld for individuals with disabilities, including guaranteeing access to inclusive education. The four-month convention concluded by redefining the term 'disability' to include: "those who have long-term physical, mental, intellectual or sensory impairments, which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others" (United Nations General Assembly, 2008). More recently, in 2011, the World Health Organization (WHO) published a report on disabilities, which acknowledged two very important points: (1) individuals with disabilities face difficulties due to impairments, activity limitations, and/or participation restrictions, and (2) "disability is an evolving concept" (*World Report on Disabilities*, 2011).

[1] The Commonwealth of Pennsylvania was sued over a law which allowed public schools to deny certain children access to education, particularly those with delayed development.

These two points are critical in the history of advancing rights for individuals with disabilities because they (1) act as a global recognition of their struggles throughout history, and (2) recognize that perceptions, and medical and legal definitions are changing and will continue to change with our developing society. As a result of these reports and persistent activism, formally used terms like 'retarded,' 'crippled,' and 'mute' are no longer appropriate, and terms like 'individuals with disabilities' and 'individuals with special needs' are more prominently used umbrella terms to describe a wide range of impairments.

For this Interactive Qualifying Project, it was important to understand not only the safety considerations, but also the ways in which to encourage developmental growth for individuals with disabilities. In the following two sections, we will address the safety (see *Section 2.2)* and developmental needs (see *Section 2.3)* for individuals with disabilities.

**Section 2.2: Reviewing Safety Considerations Necessary for Individuals with Special Needs**

The terms 'cognitive disabilities' and 'developmental disabilities' describe a vast range of disorders and impairments (Langtree, 2016; CDC, 2015). Cognitive disabilities usually refer to any disability affecting mental processes, such as: mental retardation, attention-deficit hyperactivity disorder (ADHD), dyslexia, aphasia, brain injury, language delay, and learning disabilities (NSIP, 2017). 'Developmental disabilities' is considered an umbrella term that can include cognitive disabilities, physical disabilities, or sometimes both (AAIDD, 2010). Some examples include: cerebral palsy, epilepsy, autism, hearing loss, down syndrome, mental retardation, spinal injury, and brain injury (NSIP, 2017). Although the characteristics of people with mental disabilities can vary, many of these disabilities have similar trends. Cognitive disabilities generally cause delays in communication, sight, learning, behavior, and/or attention . Delays in sensory and auditory development are often viewed as major issues in our society because of the high value we place on oral communication and sensory reactions (Smith & Tyler, 2009).

Similar to cognitive disabilities, physical disabilities and health impairments can cause a spectrum of behavioral, developmental, and physical limitations and challenges. The term 'physical disabilities' can be separated into 2 categories: acquired and genetic, both causing

varying severities of mobility handicaps (House with No Steps, 2015). The main difference between these subcategories is the timeframe in which the disorder becomes apparent; acquired disabilities occur after birth, while genetic disabilities occur before birth (House with No Steps, 2015). Acquired brain and spinal cord injuries can both cause developmental, mobility, personality, and sensory changes/disorders. The term genetic disorders describes a wider range of physical disabilities, including: cerebral palsy, epilepsy, muscular dystrophy, etc. (House with No Steps, 2015). Generally, each of these disorders cause loss of muscular tonnage, as well as unusual and sometimes uncontrollable movements. With many neurological disorders, i.e. cognitive disorders, commonly affecting mobility, there are often overlapping disorders and/or symptoms (Elliot et. al, 2002). Due to increased potential health risks for individuals with physical disabilities, caregivers, guardians, and educators must continue to be willing to modify the physical space that individuals with disabilities interact with.

Individuals with cognitive and/or physical disabilities require accommodating environments (Smith & Tyler, 2009) because as previously mentioned the complex nature of disabilities can make non-inclusive environments, that the general population uses, unusable and/or dangerous. One way engineers and architects have been able to create accommodating environments has been through universal design. Universal design was an architectural standard created to allow any person to easily access and enjoy any part of a design. Coined by architect Ronald L. Mace, universal design aimed to improve the standards of design for every person. Mace defined universal design as the concept of designing all products and the built environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life (Center for Universal Design, 1997). The Center for Universal Design, founded through North Carolina State University, created seven principles to encompass the ideals of universal design. These principles aimed to follow Mace's definition as closely as possible, to allow people of all ages, abilities, and statuses of life to use whatever product was designed. These seven principles include equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort requirement, and size and space for approach and use. The specific details of these principles can be seen in *Appendix A*.

**Section 2.3: Assessing Ways to Meet the Developmental Needs of Individuals with Disabilities**

Like the outdoor environment, indoor spaces like special education classrooms, require diligent care in the placement of every detail of the room, so that the safety of individuals with disabilities is upheld. Special education in the United States is a curriculum based on individualized education plans (IEP) and Section 504 accommodations for latency and adolescents with disabilities (Smith & Tyler, 2009; Weber M. C., 2010). The curriculum encompasses a variety of approaches and practices to assist students with disabilities to gain access to the general education curriculum (Smith & Tyler, 2009). In their book, Introduction to Special Education, Deborah Smith and Naomi Tyler (2009), highlighted studies that have shown that the physical environment for all children plays a large role in their education and overall advancement, and even more so for those with special needs (Smith & Tyler, 2009). The placement of seats, color scheme, posters on the walls, classroom aroma, and presence or absence of technology each play an important role in either enhancing, distracting or having a neutral effect on a student's ability to learn and grow in their environment (Smith & Tyler, 2009). This is even more true for students with special needs. Authors, Jessica L. Bucholz and Julie L. Sheffler, of "Creating a Warm and Inclusive Classroom Environment: Planning for All Children to Feel Welcome", recommend creating an environment that welcomes curiosity and develops a sense of community and cooperation (Bucholz & Sheffler, 2009). To achieve this, the authors, along with other educational researchers, suggest the use of light colors, decorations that aid in teaching, and space, so that students have access to all of the features in the classroom. At San Elijo Elementary School in California, special education classrooms exemplify each of the key points made by Bucholz and Sheffler. Classrooms at San Elijo have yellow or tan wall colors, features that are accessible at multiple heights, and open space that allows for easy wheelchair transportation (Erickson-Hall Construction, 2017). The concepts of classroom design are not only impactful for special education teachers to get more student interactions, but designing a classroom can affect the overall cognitive and physical developments and achievements of students.

As of 2013, over 100,000 non-profits specializing in human service care were recorded in the United States (National Center for Charitable Statistics, 2003). Each of these non-profits "support the personal and social development of individuals and families; provide care, protection and supervision; and enhance the individual's independence and ability to manage his or her own resources" (National Center for Charitable Statistics, 2003). One of these non-profits, the Heinzerling Foundation, located in Columbus, Ohio, specializes in providing residential and educational services for children and adults with severe to profound developmental disabilities (Dispatch, R. M., 2012). The foundation serves 200 individuals, where 90% of their residents use wheelchairs, 80% are visually impaired, and 46% are hearing impaired (Dispatch, R. M., 2012).

In 2012, the Heinzerling Foundation, through fundraising, was able to establish a universal outdoor sensory area for their residents. The area was separated in 4 quadrants: a sound garden, a movement area, a fragrance garden, and water features (Dispatch, R. M., 2012). Each of the quadrants were designed to meet the needs for individuals with disabilities while also integrating special education. Interactive features like the outdoor xylophones are accessible for multiple heights so that each resident can utilize the features. As mentioned previously, the majority of the residents at the Heinzerling Foundation have visual and/or hearing loss. With that in mind, the directors, staff, and landscape architects, designed an outdoor environment that allowed and promoted sensory stimulation and cognitive development for individuals with these specialized impairments (Dispatch, R. M., 2012). Through these 4 quadrants, Robert Heinzerling, director of the Heinzerling Foundation, said they were able to design a "loving environment" that fit the needs of all of their residents (Dispatch, R. M., 2012). The design and build took the foundation 5 years and cost approximately $400,000. Through the implementation, staff are now able to integrate their special education lesson plans outdoors.

Sensory gardens, like the one at the Heinzerling Foundation, are self-contained areas with the specific purpose of stimulating all five senses while exhibiting all seven principles of universal design (see *Appendix A*) and also special education principles to allow any individual to access every feature equally (see *Figure 5*). The overall architecture of sensory gardens focuses heavily on providing heightened experiences for senses that may not be targeted in

typical gardens; specifically hearing, touch, and taste. Sensory gardens are designed to be fully immersive and interactive. Being in a self-contained area, sensory gardens are able to provide an enjoyable experience to a wide variety of users in an educational or recreational setting. “These types of gardens are popular with and beneficial to both children and adults, especially those who have sensory processing issues, including autism and other disabilities” (Many Benefits of Sensory Gardens, 2017). Sensory gardens can be enjoyed in a variety of ways, from planting herbs and flowers to the simple passive pleasures of being outdoors among nature. There are three key concepts regarding how sensory gardens influence a person: affordance, information, and information pickup (Hussein, 2012) (see *Appendix B*). If designed well, sensory gardens can prove to be a valuable resource for education and recreation (Sensory Trust, 2009).

Figure 5: Tower Botanic Garden in Boylston, MA. An example of a sensory garden that incorporated universal design principles. Shown here are features that are accessible to people who have various mobility ranges.

The design process for sensory gardens and other multi-sensory environments requires landscape architects to focus on “making matches between the child’s [or person’s] ability and the task difficulty” (Pagliano, 2016). In a recent case study of sensory garden models, the author, Deborah Ann Bowers, outlined the various precedents that create a restorative garden. Some of

these features include: water features, physical enclosures, tactile/textual objects, and visually appealing features. Along with the simple presence of these features, Bowers, along with other sensory garden researchers agree that spatial configuration is a key component to designing a sensory garden (Bowers, 2003). Spatial configuration in a sensory garden setting is considered a balance between open space and solid mass. Similar to the spatial configuration concept that special education teachers use for their classrooms, landscape architects when designing sensory gardens must consider the ways in which different sensory features can influence a person (Bowers, 2003). The overall impact of sensory gardens is based on the combination of the presence of the multi-sensory/interactive features, and the locations of those features.

**Section 2.4: Discussing Care Options for Residents at Seven Hills Pediatric Center**

For our Interactive Qualifying Project, our team worked with Seven Hills Pediatric Center (SHPC), an affiliate of the Seven Hills Foundation. The Seven Hills Foundation was established in 1953 by parents seeking a safe and understanding establishment for their children with specific health needs. Since its establishment, the Seven Hills Foundation has grown to build a considerate and supportive community through their 11 affiliate programs. To this day, the Seven Hills Foundation continues to assert their impact statement as: “programs and services support children and adults with physical, emotional, developmental, social, substance abuse, and other significant life challenges” (Seven Hills Foundation Inc., 2017). Developed as a nonprofit, the foundation has established itself as “one of the largest health and human service providers in Massachusetts and Rhode Island” (Seven Hills Foundation Inc., 2017). As of 2014, the combined 11 affiliates of the foundation served 75,948 individuals.

In total, SHPC employs approximately 230 individuals, and serves approximately 82 children/young adults (ages 6 months to 54 years) ("2014 Annual Report," 2015). The SHPC follows the impact statement: “ [to provide children and young adults] all the necessary medical, nursing, therapy, educational, and leisure services possible to enhance their quality of life” (Seven Hills Pediatric Center, 2017). The program accomplishes this mission through its four residential options (long-term care, short-term respite care, short-term post hospitalization care, and a family-centered individualized home), as well as through its Special Education school,

Seven Hills Academy. Also, illustrating this mission, was the renovation of the entire indoor facility that was completed in 2003 in the efforts of promoting a stronger emphasis on individualized care and increased integration of technology. In special education classrooms, yellow and other light colors were used to color the walls and more windows allowed for natural light. Simple decorations allowed for residents to better focus on tasks at hand, and classroom size was increased so that residents are not crowded.

Despite indoor renovations, SHPC has yet to update their outdoor area, which is separated into 3 sections: Gazebo area (see *Figure 6*), Koi pond area, and Walmart Plaza. Each of these areas has several different sensory features, including: wheelchair accessible swings, a metal musical installation, a bridge feature, and spinners. Unfortunately, most of these features are either unsafe or just underutilized (see *Figure 7*). However, with continued support via funding, volunteers, and growing interest in discovering new special education services for their outdoor area, SHPC continues to make strides in improving the care and education for their population.

Figure 6.

Figure 7.

Detailed in the figures (*Figure 6* and *Figure 7*), are the prominent features that were present at the Gazebo area at SHPC prior to our alterations.

## Chapter 3: Methodology

This project aimed to assist the residents at Seven Hills Pediatric Center by re-designing the facility's outdoor area into a sensory garden that incorporated universal design principles, and supported the cognitive growth and development of residents. To complete this goal we engaged in a human centered engineering design approach to produce designs of recreational activities that integrated the needs of residents, staff, and family members regardless of the user's cognitive, physical or developmental ability. The human centered design approach consists of three key points: desirability, feasibility, and viability. Desirability encompasses discovering the environment and individuals that the design is intended to aid (IDEO, 2009). This is to ensure that the development of the design is focused around the client's needs and desires. Feasibility entails using the information gathered in the desirability stage to create a design that caters optimally to its intended function for the target audience. The designs focus primarily on the common activities of individuals and their needs during those activities (Elmansy, 2017). This follows with viability, or developing blueprints of initial ideas that can be presented to the client. A cyclic process then begins; the blueprints are presented to the client, the client reviews the designs and proposes changes, and the designs are then amended based on that feedback. Similarly, the engineering design process follows a structured, deliberate sequence of activities intended to deliver a top quality solution to an identified challenge (Groves, J., Abts, L., Goldberg, G., 2014). This cyclic process consists of seven key steps, which are similar to the human centered design approach (Teach Engineering, 2017). Following the main points of both human centered design and the engineering design process, we accomplished our goal using these objectives:

**Objective 1:** Identifying the physical needs and requested accommodations of clients at Seven Hills Pediatric Center.

**Objective 2:** Determine design criteria and develop landscape designs and features.

**Objective 3:** Evaluating and implementing landscape designs and features.

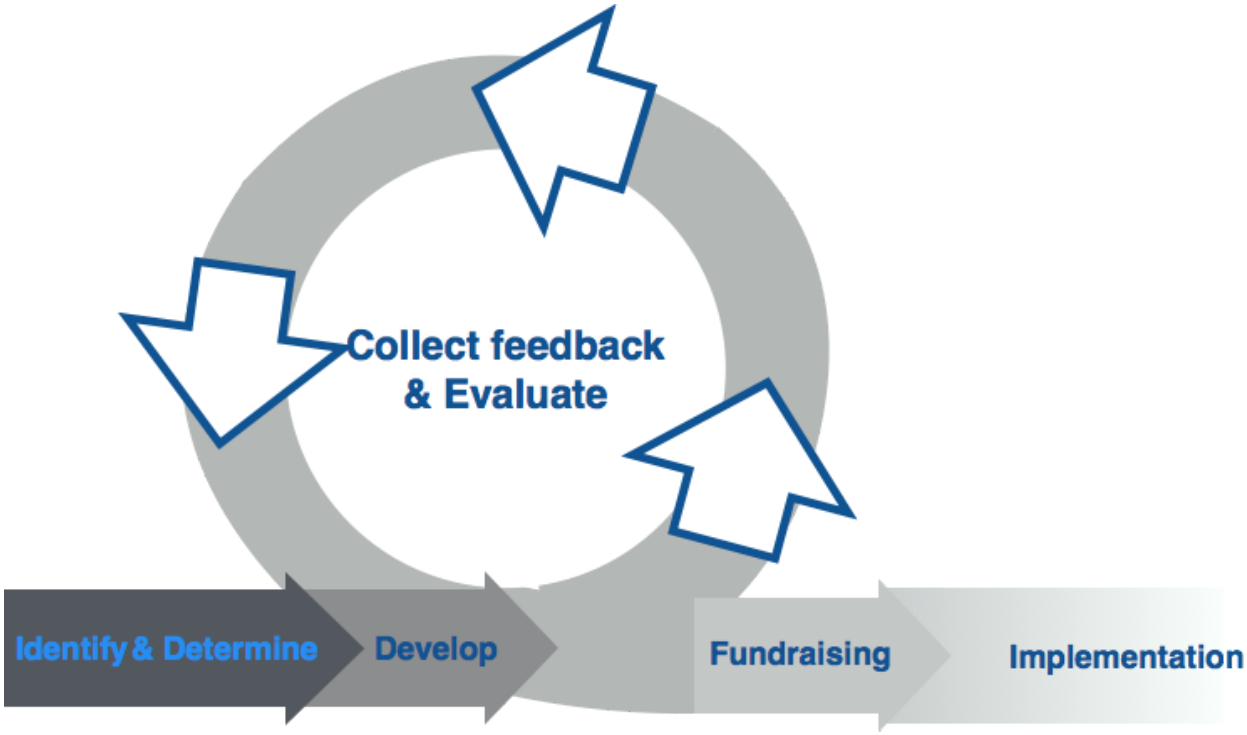



Figure 8. Outline of Methods.

In *Figure 8*, the objectives are visualized in a step-by-step manner that illustrates both the human centered design approach and the engineering design process. Although fundraising is not part of our human-centered design process, we have shown it as an extra step in the process to indicate its importance in transforming a design into a physical feature. Each of these outlined objectives are further detailed in the following subsections.

**Section 3.1: Objective 1: Identifying the Physical Needs and Requested Accommodations of Clients at Seven Hills Pediatric Center**

To obtain information regarding the physical and educational needs of the Seven Hills residents, we used a variety of data collection methods. These methods included visiting existing sensory gardens, surveying staff and family members, conducting semi-structured interviews with staff members, and direct observations of the residents. These different methods were

instrumental in identifying the exact needs of the residents, which greatly influenced our design process methods.

Section 3.1.1: Visits to Sensory Gardens

Exposure to existing sensory gardens allowed us to better visualize real-world designs and more importantly, witness how people interacted with the space. We chose to visit gardens that were within approximately a fifty mile radius of Worcester [2], which allowed us to see a variety of land areas, locations (public versus institutional, i.e. hospitals), and universally accessible features. The gardens we visited were chosen for their variety of plants, versatility, sensory aspects, and their focus on universal design.

Initial data collection at each of these gardens involved pictures and notes. Preliminary notes focused on plant types, pertinent sensory features, and spatial configuration of the property. These notes were useful during our initial meetings with SHPC. Through our meetings, we realized the importance of multisensory stimulation and accessibility for the residents. We also reviewed example criteria from studies by the University of California at Berkeley (Marcus, C. C., & Barnes, M., 1995; 1999) and the University of Arizona (Pedersen, 2013) (see *Appendix J*). With this in mind, we proceeded to convert our qualitative sensory garden data into quantitative data that helped us form conclusions on each sensory garden that we visited based on accessibility, safety, and appeal to each of the senses. From these case studies and personal correspondence with SHPC, we analyzed each garden using our own weighted criteria matrix, which assessed each sensory garden based on a set scale. For each criteria, we used a rated scale, with values ranging from 1 to 5, where 1 was poor and 5 was excellent (see *Appendix C)*. With the results of the garden visits and their analysis, we were able to decide which gardens were best to further evaluate for our project.

[2] The fifty mile proximity was chosen in order to view examples in the same climate as Seven Hills and because of convenience.

Section 3.1.2: Directed Observations

To better understand the needs of the SHPC residents, we conducted observations at the facility in special education classrooms. We completed observations between Monday and Thursday, during the peak of daily activities per the recommendation of an Occupational Therapy Assistant at SHPC and a special education researcher at Worcester State University (S. Fan Foo, personal communication, April 7, 2017; B. Heath, personal communication, May, 2017; McLeod, 2015 ). We began each of our observations by properly introducing ourselves to the residents and staff members, so that they understood our purpose of observing their activities. During observations, one team member led the conversation with staff members, while another took notes on the activities and conversation (see *Appendix G*). Our conversations with staff members focused on discussing the typical schedule of classroom activities, as well as learning about the behaviors, likes and dislikes, and physical and cognitive abilities of the residents. Through these observations, we obtained a clear picture of the approach SHPC follows to advance the cognitive and physical development of individuals with disabilities.

Section 3.1.3: Surveys

We generated surveys in order to gather information regarding the needs of the residents at Seven Hills Pediatric Center, and to introduce initial design ideas from our site visits. Two separate surveys were created to poll both staff and family members (see *Appendix D* and *Appendix E*). We chose to use hard copies for surveying the staff and both hard copies and online surveys were used for the family members per recommendation of the director of SHPC (M. Conway, personal communication, May 26, 2017). This method of survey distribution was recommended to us because of past success with receiving feedback from hard copy surveys in a timely manner. Similarly, the director emailed the online surveys to the families, as that was the best way to get feedback from them. Hard copies were also distributed to families as they visited.

Both surveys started out with some general questions about the recipient, asking them some questions about senses and their time with Seven Hills. Each question was structured in such a way that was clear and concise, and asking only one question at a time in order to minimize time consumption, and eliminate any possible confusion that a participant may have

(Parasuraman, A., 1991). The second half of the survey pertained to the design ideas themselves with each type of design including a picture to improve clarity. Participants were asked to rank their preference of the proposed features to give insight on what features to focus on (Fowler, 1995). The information collected from these surveys was then used to plan key design criteria and further develop interview questions for staff members.

Due to a formatting error and confusion in the wording of our questions, we received two contrasting results from some of the questions asked in our survey. Pictured in *Figure 9* are the first and second pages of the "Design" section of our survey. In this section we asked family and staff members to rank 6 multisensory features in order, 1 being most important and 6 being least important. Because of some confusion regarding the ranking questions we had in our surveys , our team separated survey responses into two categories: ranked responses and rated responses (see *Appendix D* and *Appendix E*). Ranked responses were those that answered ranked questions by listing the described choices in order of preference. Rated responses were answered by assigning a value to the choices.

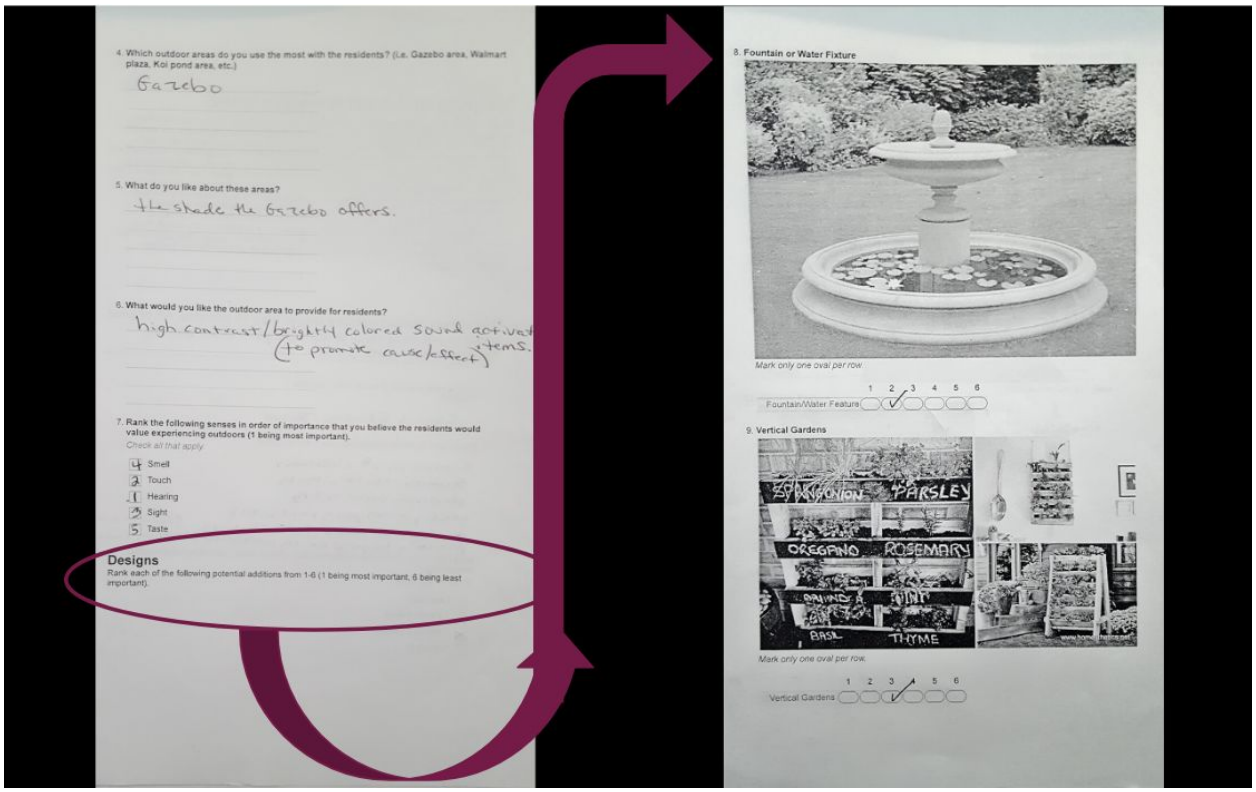



Figure 9: Illustration of the discrepancy in the survey format.

### 3.1.4. Semi-Structured Interviews

We conducted interviews with staff members at Seven Hills in order to further clarify the needs and requirements of the residents and staff members of Seven Hills. As of June, 2017, there were approximately 230 staff members that worked around the clock to serve the 82 residents at Seven Hills. We only managed to conduct 4 interviews, and while we had hoped for more, staff availability was limited. Of these 4 interviews, however, we discovered that there were similar findings between them and our various surveys.

Interviews were semi-structured in nature, with some initial questions developed in advance. We integrated flexibility in their sequencing to promote flow of conversation (Padgett, D. K., 2008). Topics of interest were outdoor activity, sensory stimulation, and potential features. Instead of asking broad questions pertaining to each of these topics, we used multiple questions to obtain more precise information and also to help steer the conversation in a natural way. When

applicable, we would ask the interviewee to elaborate on their answers, if at all possible (Kennedy, M., 2006). The initial set of questions can be found in *Appendix F*.

## Section 3.2: Objective 2: Determine Design Criteria and Develop Landscape Designs and Features

### Section 3.2.1: Determining Design Criteria

Following the collection of Objective 1 data, we compiled our results and developed a set of design criteria for the outdoor space at SHPC. These criterion were useful during our design process, which is explained in the subsections below.

### Section 3.2.2: Creating Sketches and 3D Renderings of the Target Area

To assess the outdoor space, we began by using Google Maps and pictures we had taken of the layout at SHPC to draw out rough sketches of the gazebo area (see *Appendix H*). This gave us a better idea of how we could use the space. With preliminary drawings completed, we added potential multisensory features to locations we thought would fit the requirements outlined in our design criteria. Rather than redrawing the outdoor area multiple times, we made copies of our initial drawing, so that we could maintain a consistent scale of the space and size of features (Scale and Proportion, 2017). These measurements aided us further in our development of drawings of the Gazebo area.

To represent the space more accurately, we used the measurements of the desired area to create a three dimensional rendering of the space. We used the program SketchUp to complete this task. SketchUp is produced by Trimble® , a company that works on location-based solutions to promote productivity and profitability (About trimble, 2017). This three dimensional modeling software was easy to learn and also allowed for small edits to be made to a layout, making the production time for our renderings rather short. This preliminary rendering included the pathways, the gazebo, trees, and other current features in the space. The rendering went through multiple iterations by adding and moving potential features (see *Appendix I*). This method

allowed us to visualize the space for ourselves, and also gave us the opportunity to show the staff at SHPC how we planned the final layout. The staff then provided feedback and gave suggestions that further influenced our final layout.

We used a similar process when developing designs for each feature. We began with sketches of our original ideas, and then moved them into a modeling software for development. For this task, we used Solidworks, which is a modeling software that is widely used by schools and businesses. This program is produced by Dassault Systèmes, a company that produces three dimensional design and engineering softwares (Dassault Systemes, 2017). Using Solidworks, we were able to produce three dimensional renderings of each of the developed features. These renderings allowed us to further review and determine potential locations for implementation, based on each feature's size and shape (Scale and Proportion, 2017).

**Section 3.3: Objective 3: Evaluating and Implementing Landscape Designs and Features**

Section 3.3.1: Reviewing Designs and Feedback

After drafting designs, we then sought feedback on whether or not the design would benefit the SHPC community, i.e. residents, staff, and family members. We conducted weekly meetings with Mary Cassidy Conway, Director of Education & Therapy at SHPC, Brian Heath, OTA, and other staff. During these meetings, we set aside time to discuss our proposed designs and ideas. We reviewed the designs with SHPC providing thorough explanations of their functions and how we envisioned them in the desired location. They would then give their input, whether it was constructive criticism or confirmation. We then took this information and amended the designs accordingly.

Section 3.3.2: Implementation

With a final landscape design completed, we began the process of implementation. Considering cost constraints and other feasibilities of the potential features, we selected one feature to build in the desired location for SHPC. To build this feature, we used materials purchased at local hardware and supply stores and also from online suppliers. To complete our final landscape design, we researched current models on the market that fit the size, shape, and

purpose of the features included in our design. Details of their use, maintenance, prices and purchasing were provided for SHPC. Per the recommendation of Mary Conway and Brian Heath, fundraising was left to SHPC.

# Chapter 4: Results & Findings

Following our outlined objectives and their corresponding results and data, we will discuss the various findings that we identified. Our team used each of the findings to develop an effective design for SHPC, with the intention of developing an outdoor environment suitable for the residents' needs, while also reiterating the same cognitive development the facility promotes during special education classes. In the following subsections, we discuss the results and findings in the same chronological order that we performed our methodology; findings can be found bolded within the text.

**Section 4.1 Assessing sensory garden models for implementation at SHPC's outdoor space**

As previously mentioned, the 2003 renovation promoted a stronger emphasis on individualized care and increased integration of technology for the facility's indoor space (see Section 2.4). The outdoor space at SHPC is separated into 3 major areas: Gazebo area, Koi Pond area, and Walmart Plaza, with each of these areas hosting their own unique features. The Gazebo area offers shade (gazebo and trees), auditory stimulation (musical chimes), and vestibular motor sensation ("bumpy bridge[3]" feature) (see *Figure 10*). The Koi Pond area provides auditory stimulation (koi pond with a waterfall) and vestibular motor sensation (wheelchair accessible swing) (see *Figure 11*). Finally, the Walmart Plaza has seating, vestibular motor sensation (swing), and shade (tree) (see *Figure 12*). Though each of these features offers some sensory stimulation, the outdoor space could still benefit from additional sensory objects. Through directed observations and interviews with staff members, our team recognized the importance of implementing new outdoor features that could match the advancements made to the facility's indoor space in 2003.

[3] The "bumpy bridge" feature, as it was appropriately named by staff and family members at SHPC, was a 12' x 5' sized bridge with a wavy style designed walkway that was intended on providing vestibular motor stimulation rather than having a smooth and level surface.

Figure 10: Gazebo Area.

Figure 11: Koi Pond Area.

Figure 12. Walmart Plaza.

During directed observations (see *Appendix G*), it also became apparent that sensory stimulation through assistive technology played a major role in the residents' education. Many of the staff members who we spoke to during observations said they tried to incorporate the senses into the classroom setting. This was accomplished by implementing technologies such as Eyegaze and iPads into most of the classrooms. As we observed, the Eyegaze technology allowed for the residents to make selections from a screen based on their eye movement. These selections often generated an auditory and visual response from the screen (i.e. a dog was chosen from a list of animals and its bark was heard). The iPads were also used for auditory and visual stimulation, which were operated by the resident tapping an adaptive switch with their head or chin. Because many of the residents had limited mobility, the adaptive switches enabled them to interact more with their environment without putting too much strain on their body. The concept behind both the Eyegaze technology and iPads of easing the physical exertion of residents, while also allowing increased independence, was factored into our finalized design. For example, the recommended fountain feature would allow residents to interact with a multisensory object without major physical exertion, and the implemented vertical garden would allow residents to reach out and touch the plants regardless of their mobility limitations. By incorporating this concept into our design, we attempted to mirror the indoor environment to the outdoor space.

In a 1995 case study conducted by Clare Marcus and Marni Barnes, professors at the College of Environmental Design at the University of California Berkeley, the authors found that

the described criteria[4] outlined in *Appendix J* were most useful in polling visitors in regards to the environments at various sensory/healing gardens. As mentioned previously, during our initial stages of research, we visited 7 sensory gardens that provided a variety of design ideas and considerations, such as vertical gardens and raised garden beds, that would later become important for our design process (see *Section 3.1.1*). Through the criteria outlined by Marcus and Barnes, our team created a set of qualitative criteria (see *Appendix J*). The purpose of this criteria was to allow each team member to document personalized accounts of each sensory garden, while also ensuring each team member was focusing on the same aspects and features at each sensory garden. From our qualitative analyses, we then produced a quantitative analysis criteria (see *Figure 13*) to better judge the effectiveness and presence of each of the senses[5]. By quantifying our visits, we were able to compare each of the gardens in a more logical way (see *Appendix C*) .

**Through our criteria tables, our team realized (1) that our design needed to be adjusted to fit the space that SHPC allocated to our team, (2) that scent, sight, hearing, and touch were all key elements to the sensory gardens we visited, and (3) that maintenance of the outdoor area would become of more concern after our IQP was completed, i.e. during winter and other less optimal weather.** The sensory gardens at Tower Hill Botanic Garden in Boylston, MA received the overall highest score: 23/25 (see *Figure 13*). Tower Hill appealed to all of the senses, without the added caveat of causing overstimulation to visitors. One of the gardens at Tower Hill, The Court: A Garden Within Reach (see *Figure 14)*, even follows the universal design criteria along with national regulations previously mentioned in our paper (see *Appendix A; Section 2.2*). As of June of 2017, the Court included a vertical garden, a raised garden bed, a water table, a planter pulley system, and a raised garden bed with seating. Each of these features help create an inclusive environment that fosters cognitive growth via multisensory stimulation (see *Figure 14*). The Ferguson Greenhouse located at Wellesley College received the lowest score: 11/25 (see *Figure 13*). The garden received low scores mainly

[4] Similar criteria outlined by the University of Arizona confirmed the list that our team utilized for analysis (see *Appendix J*).
[5] Taste was not included in our criteria because of its lack of importance for our final design.

because of its restrictive space that did not allow for easy access, and its lack of ventilation that caused the indoor facility to become very humid and hot. Besides the organization issues, our team felt that the plants maintained at the Greenhouse's facility would not be beneficial for implementation at SHPC because of their lack of interactivity (see *Figure 15*). For our table of scores of the gardens, see *Appendix C*.

| Criterion | Tower Hill | Ferguson Green House |
|---|---|---|
| Accessibility and Safety | 5 | 2 |
| Appeal to sight | 5 | 5 |
| Appeal to sound | 4 | 1 |
| Appeal to smell | 4 | 2 |
| Appeal to touch | 5 | 1 |

Figure 13: Sample Table of Garden Scores

Figure 14: Design layout of the Court.

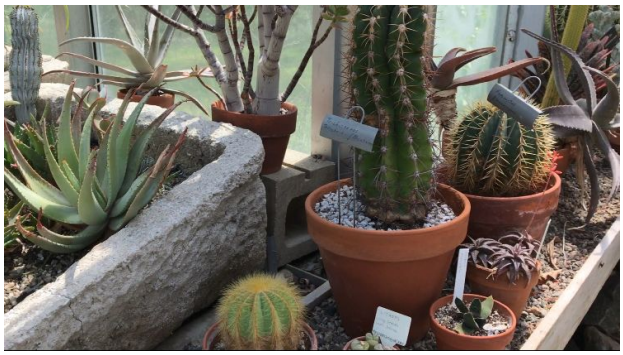


Figure 15: Plants present at the entrance of the greenhouse.

**Additionally, we discovered that the effective utilization of the horizontal and vertical space increases user accessibility options.** As mentioned previously, spatial configuration is an important consideration for both sensory gardens and special education classrooms (see *Section 2.3*). Imaged in *Figures 18 and 19* are two examples of vertically and horizontally designed features present at The Court. The circular raised water feature pictured in *Figure 16* depicts a horizontal use of the space, while also allowing users of all abilities, like individuals who have wheelchairs, to interact with it because of its raised designed. Comparatively, *Figure 17*, highlights the benefits of vertical space: providing users of various heights the opportunity to interact with a multi-sensory feature. By including both horizontal and vertical features, our team found that Tower Hill optimized their space, while also producing a more universal environment for all visitors.

Figure 16: Horizontal fixture (water feature).

Figure 17: Vertical fixture (vertical garden).

| Criterion | Description |
|---|---|
| Sensory Appeal | Does it appeal to touch, smell, sight, sound, & taste? |
| Accessibility & Safety | Is the design *universal*? Is it safe? |
| Maintainability & Durability | How easy is it to maintain? Low cost? Lifespan of feature? |

Figure 18. Criteria checklist implemented to review designs and recommendations.

Utilizing the two findings discussed above, we completed our own design criteria checklist that we used when designing each of our proposed features as well as the overall landscape design (see *Figure 18*). The criteria table includes three key concepts that we hoped to incorporate in our design. These criterion were decided within the group following the completion of Objective 1, where we gathered information on sensory gardens, and the needs of SHPC.

**Section 4.2. Utilizing exploratory and personalized results to understand the needs of SHPC**

As mentioned previously, surveys for both staff and family members were conducted because of their convenience and quick response time. From staff surveys, we received 27 responses from a range of occupations (see *Appendix D*). From family surveys, we received 9 responses from a range of family member ages, and visitation frequency (see *Figure 20*). These varied responses proved to be beneficial because, as mentioned previously (see *Section 3.1.3*), multiple perspectives are essential for the human centered design process. Responses were not coded or ranked, rather all responses were equally valued. This method of analysis was chosen because of the limited number of responses collected and per the recommendation of the Director of Education & Therapy at SHPC, Mary Conway.

The frequency of taking the residents outside and the most frequented locations were questions asked to both the staff and families. It was apparent from both survey responses that the majority of staff and family members were only able to take the residents out about 1-5 times a month (see *Figure 19* and *Figure 20*). It also became clear that when staff and family members

took the residents outdoors, they often took them to either the Koi Pond or Gazebo areas (see *Figure 21* and *Figure 22*).

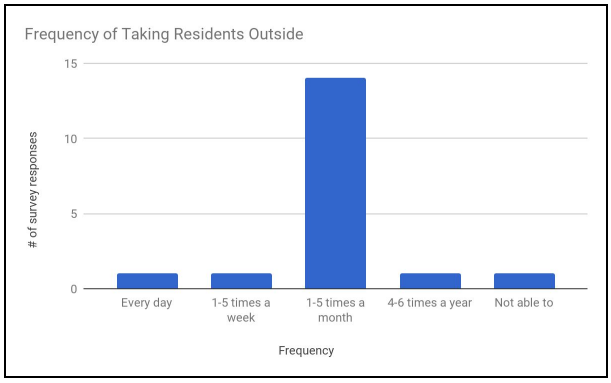



Figure 19.

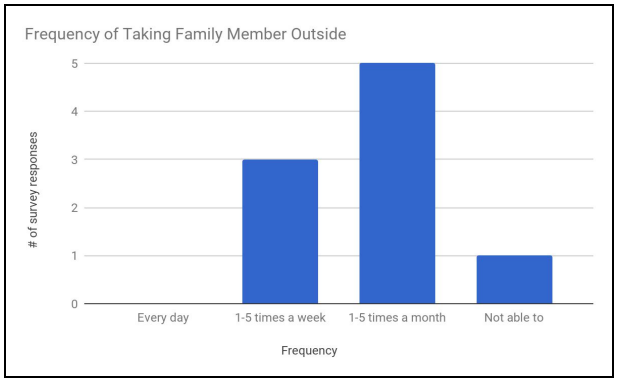



Figure 20.

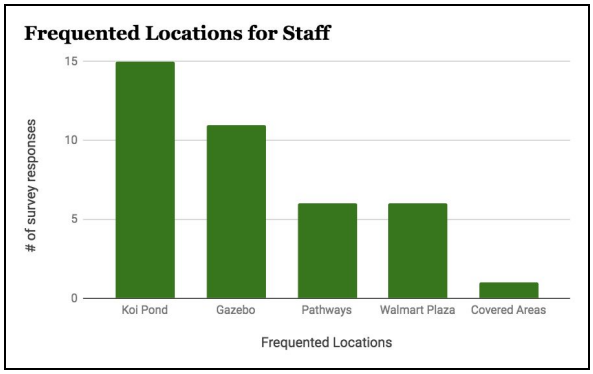



Figure 21.

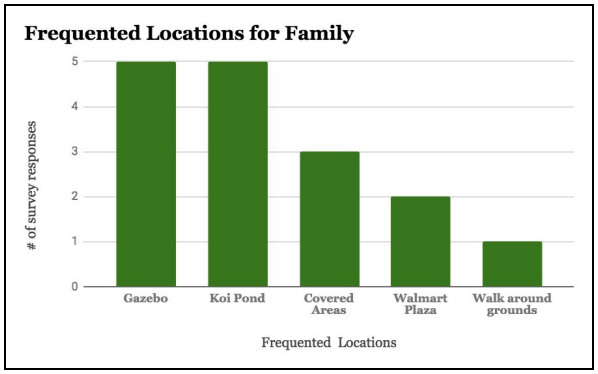



Figure 22.

From ranked surveys, our team found that the top three features were: (1) auditory features, (2) fountain/water features, and (3) raised garden beds. The least valued feature from these surveys was the educational feature (see *Figure 23*). *Figure 23* details the scoring given to each of the features; features listed in the figure are in decreasing order, most important to least important. The ranking of the proposed features were taken into consideration during our design process. Ranking of senses also followed a similar analysis, with hearing being the most valued feature and taste being least valued (see *Figure 24*); similar to *Figure 23,* senses are organized in decreasing order.

| Features | Total |
|---|---|
| Auditory Features | 72 |
| Fountain | 57 |
| Raised Beds | 55 |
| Vertical Gardens | 53 |
| Raisable Features | 52 |
| Educational Features | 23 |

Figure 23: Ranked feature analysis.

| Senses | Total |
|---|---|
| Hearing | 55 |
| Touch | 64 |
| Sight | 76 |
| Smell | 56 |
| Taste | 16 |

Figure 24: Ranked senses analysis.

Rated survey results followed similar trends made in ranked surveys. The fountain feature, auditory features, and vertical gardens (see *Figure 25*) were considered the most important features proposed in the survey. With the exception of taste, all of the senses were considered equally valuable additions to the outdoor area. Through discussions with staff and data collected from surveys, we discovered that the fountain feature was considered most valuable because it provided auditory stimulation.

| Features | Avg. Rating |
|---|---|
| Fountain | 1 |
| Vertical Gardens | 1 |
| Auditory Features | 1 |
| Raisable Features | 2 |
| Raised Beds | 3 |
| Educational Features | 4 |

| Senses | Avg. Rating |
|---|---|
| Smell | 1 |
| Touch | 1 |
| Hearing | 1 |
| Sight | 1 |
| Taste | 6 |

Figure 25: Results of rated features and senses from staff and family surveys.

An added benefit of the family surveys was the additional personalized feedback that the family members provided. By leaving a space in our surveys for family members to provide additional comments, we received further clarification as to what considerations we needed to factor into our design. The attentiveness of the comments further emphasized the concerns and desires for the outdoor space:

- “Loud noises can cause my daughter to startle so I wouldn’t want anything too loud”
- “Would like some shade. He’s not used to bright sun”
- “Loves moving forward, loves texture under wheelchair wheels, loves moving air.”

The concerns for overstimulation, i.e. sun exposure and loud noises, which had also been mentioned by staff members, were valued strongly for our design process.

**Our results supported our finding that multisensory interactive features would promote increased outdoor area usage.** We found that through multisensory interactive features, the personalized care and special education offered to residents indoors could be translated to the outdoor area. From the interviews and surveys, we learned that (1) a few of the residents at the facility were prone to seizures when exposed to over stimulation (i.e. loud sounds, over exposure to sunlight), (2) a few of the residents were unable to travel outdoors because they required a power source for their ventilator systems, and (3) most of the residents had some kind of respiratory difficulties that restricted their outdoor time. To address these concerns, the interviewees suggested we considered electric power sources outdoors, outdoor shade features, and auditory features that mirrored natural sound intensities like birds chirping.

Based on our findings, we chose the Gazebo area because of its close proximity to the classroom entrance of SHPC. This gave the staff easy access to an outdoor area with the option to return indoors quickly, which made it an optimal location to accomplish our goals. In the following section, we discuss the selection and implementation of a vertical garden feature, as well as the other recommended multisensory features. A vertical garden was considered to be an excellent option to design because it met the needs and necessary accommodations of the residents, staff, and family members. Also, its simple design allowed for us to complete construction in a short amount of time (see *Figure 26*). This design offers olfactory, sight, and touch stimulation, satisfying our goals for sensory stimulation residents, and was heavily inspired by the vertical garden feature at Tower Hill Botanic Garden (see *Figure 27*).

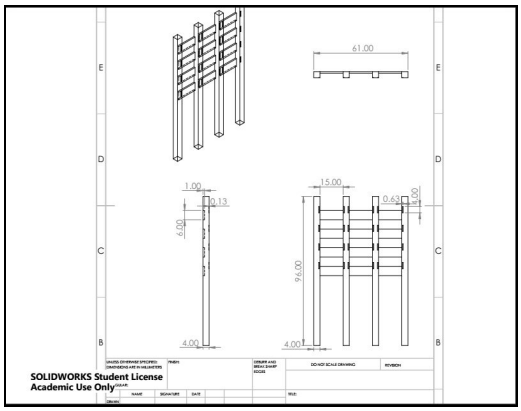


Figure 26: Blueprint of vertical garden & Figure 27: Vertical garden featured at Tower Hill Botanic Garden

# Chapter 5: Designs and Recommendations

With the understanding that auditory stimulation, vertical gardens, and fountains all are valued by both family and staff members, our team decided to incorporate each of these features into our final design. Additionally, the safety and accessibility concerns that were addressed during our meetings with our sponsors and during our semi-structured interviews with staff members, were all factored into each of our designs and our suggested purchases. In order to aid in the completion of improving the outdoor areas of Seven Hills, we were able to physically deliver some preliminary aspects of our proposed design by deconstructing some current features and constructing a vertical garden, as well as generate a list of means to implement our other proposed features.

## Section 5.1: Designs

### Section 5.1.1: Finalized layout

For our first deliverable, we presented a finalized layout proposition. In this finalized layout, we achieved our overarching goal of creating a universal space and an environment that incorporates multisensory stimulation. As seen below in *Figure 28*, one possible final design for the Gazebo area includes two vertical gardens, two elevated garden beds, a circular fountain, and a pergola for shade. Some solar panels are located on the roof of the gazebo to provide power to the fountain pump and a power source to the area. Having several features would allow multiple people to enjoy the area as well as add diversity to the garden space.

Figure 28: Finalized landscape architectural design for Gazebo area. This design features two vertical gardens, two elevated garden beds, a circular fountain, and a pergola.

Section 5.1.2: Deconstruction of features

For our first physical deliverable, we were successfully able to remove two features originally in the Gazebo area that were either not easily accessible, unsafe, or otherwise unusable (M. Conway, personal communication, June 2017; B. Heath, personal communication, June 2017). We first deconstructed a musical installation that featured triangles. We were informed by staff at Seven Hills that the feature was largely unused, as most of the residents could not directly use the feature themselves, or did not enjoy the noise generated by the triangles (B. Heath, personal communication, June 2017). To remove this feature, we first disassembled the wooden frame, and then proceeded to dig up the cement posts that secured the structure in the ground. Maintenance staff helped us remove the cement anchors with a tractor, which eased the workload. The second feature we were successfully able to deconstruct was a large bridge feature. The bridge was designed to add an interesting texture and surface under the wheelchairs of the residents. Unfortunately, the slope of the bridge was far too unsafe for the residents to use,

even with assistance. In order to disassemble this feature, we had to use drills and crowbars to pull up screws that had sunk into the wood and tear up each section. Upon removal of the bridge, we also discovered the bridge was riddled with carpenter ants and rot, decreasing the safety of the bridge even further. Both the musical feature and the bridge feature can be seen below in *Figure 29*.

Figure 29: Two features that were successfully removed. The feature on the left is the musical installation holding triangles. The feature on the right is a bridge.

Section 5.1.3: Pathway reconstruction

Upon the removal of the bridge feature, we discovered that the asphalt walkway did not extend beneath the bridge area. The bridge feature was resting on top of eight stone slabs, and a large patch of loose pebbles. We immediately recognized that this pathway would need to be fixed. We were advised by a staff member at Seven Hills to utilize graded base stone, which compacts as firmly as asphalt while also adding a new texture to the Gazebo area (B. Heath, personal communication, June, 2017). We purchased one yard of the graded base stone from Pinard's Landscape Supply Yard for $26, with an extra $25 charge for delivery.

Section 5.1.4: Vertical Gardens

The vertical garden was installed across from the spinner feature in the Gazebo area due to its wheelchair accessibility and convenience of installation. Because the design is small and

does not require power, it would be easy to implement in many various locations around the facility with a path and easy access to a hose. If other vertical gardens were to be implemented, we suggest placing them near a smooth pathway, so that residents have easy access to the feature.

The garden shelf had four layers of shelving and could hold up to 12 bucket planters between 4 main standing posts. To begin, we dug an 8' x 2' x 2' trench where the posts were to be buried. We then placed 5-gallon buckets in the trench where the posts would be set, and filled up the trench with dirt to be packed down. Once that was complete, we removed the buckets to leave holes where the posts could be placed and filled with concrete. Following cement regulations, the posts were buried one third of the post's height above ground, or approximately 2 feet deep (Quikrete, 2017). The dimensions for the standing frame were 7' x 6' x 4'' (including the 2 feet that were buried). We used pressure treated pine lumber for the frame because of its relatively low cost and for its high resistance to insect infestation, fungal decay, and weather induced stresses. We assembled the frame flat on the ground and then manually raised it carefully into the empty holes. After filling the remaining holes with fast setting cement, two team members held the frame vertical for 30 minutes, so the concrete could set in the correct position. The bucket planters that were inserted into the frame of the vertical garden fixture were purchased at Amazon.com, so that the facility could easily replace them if needed.

The final cost of the vertical garden came to be around $410, not including the plants. All materials were purchased at Home Depot, Lowes, Amazon.com, or Aubuchon Hardware. We bought the plants for the garden at Aubuchon Hardware in Ayer, MA, at a cost of around $150. See *Appendix K* for a more detailed cost analysis.

**Section 5.2: Recommendations**

Along with our deliverables and preliminary stages of implementation, we recommend several additional features to continue creating an interactive sensory garden environment for Seven Hills Pediatric Center. The following features are described in full detail to aid in their

application in the future. The following features are also somewhat expensive, and will require the money raised through fundraising.

Section 5.2.1: Fundraising

As previously mentioned, Seven Hills Pediatric Center is a non-profit affiliate, meaning that funds can be challenging to acquire. Several features we recommend for the further development of the outdoor spaces are quite expensive, and could generate a large strain on the budget of SHPC. To avoid this issue, we recommend the use of a fundraising platform, such as GoFundMe. GoFundMe is an excellent resource that allows for complete customization of the fundraising event, and is easy to share across multiple social media platforms. We recommend that a monetary goal of $10,000 dollars be set to ensure that not only can the following features be purchased and installed, but to pay for future maintenance costs. *Appendix L* provides a cost analysis of the following proposed features.

To begin the process of establishing a successful fundraising opportunity, we recommend working with Seven Hills Foundation's Office of Advancement. In order to create an effect fundraising event, it is imperative to clearly describe the purpose and goal of the project. We recommend that a brief description of Seven Hills Pediatric Center leads the description of the GoFundMe webpage, to provide background knowledge and prove authenticity to potential donors. This description should be followed with a clear and concise description of the purpose of fundraising, discussing both the features to be implemented, as well as the purpose of each feature.

Section 5.2.2: Elevated Garden Beds

Similar to our vertical garden design, raised garden beds were selected to help create a multisensory environment that was universally accessible. The elevated garden design selected was one manufactured and sold by Gardeners Supply Company, called the "The VegTrug". This design was chosen for its elevated garden bed with sloped walls that allowed wheelchairs to roll underneath the sides of the bed for easy access. The sloped design also would allow for a large

variety of plant life to grow in the bed, as both plants with short roots or longer roots can grow side by side. Through the proper selection of plant species, the garden bed feature would provide residents multisensory stimulation. The VegTrug model was specifically chosen for its size, simple assembly, durability, and overall quality. *Figure 30* below shows both a three-dimensional rendering of the elevated bed, as well as the actual model. The three-dimensional rendering of the elevated bed was drafted in the modeling software SketchUp. The VegTrug is approximately 70 inches long, 20 inches wide, and 31-1/2 inches tall. It is important to note that this specific model may be several inches too short, and may require additional height to allow a larger majority of the residents at Seven Hills to comfortable fit underneath the garden bed. The standard model of this elevated garden bed was $269.00, with a premium model including a Greenhouse cover and insect cover version for $328.95.

Figure 30: Elevated garden bed design. The left image is a three-dimensional rendering, while the right image is the standard VegTrug model. All other VegTrug models can be found on the Gardeners Supply Company website.

Being a rather small feature, the elevated garden bed could be placed in any desired location or alignment. And with the simple addition of wheels, the elevated garden bed could become a movable feature that could be kept outdoors or brought indoors. *Figure 31*, shown below, illustrates one potential location of the garden bed. Placements similar to that shown in *Figure 31* are strongly recommended, so that the garden bed not only receives plenty of sunlight, but is

easily accessible from the walkways. Additionally, asphalt or concrete may be used underneath wherever this elevated garden bed is placed to prevent sinking or shifting of the bed itself.

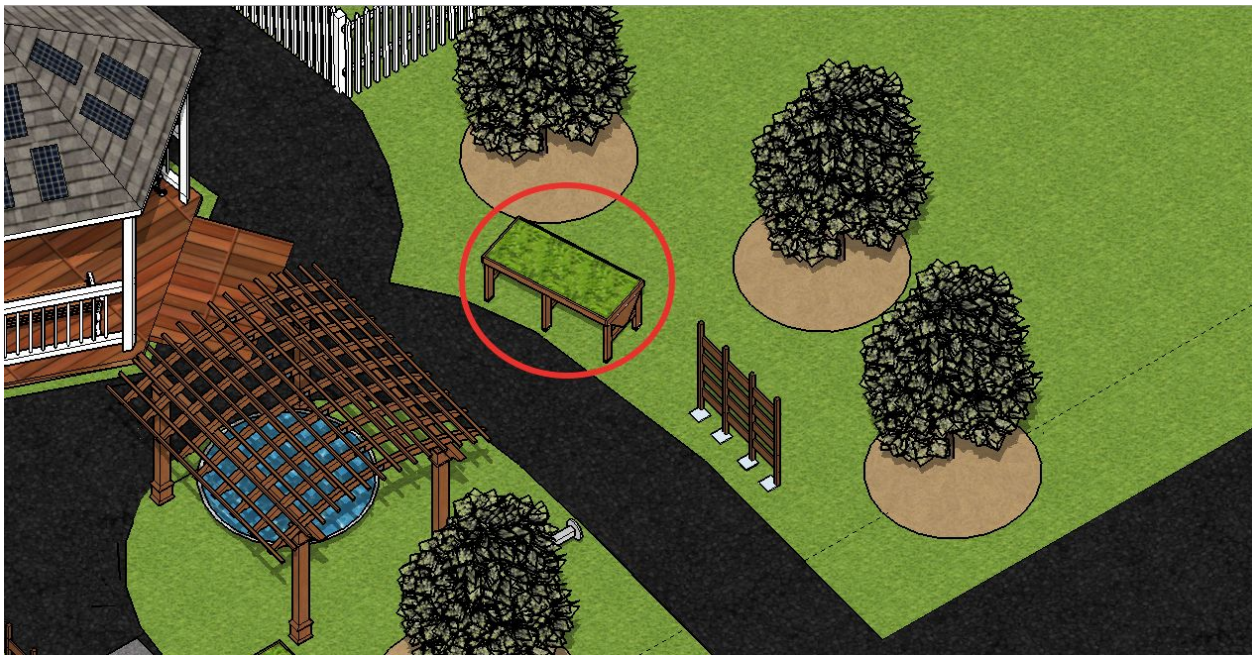


Figure 31: Potential placement for elevated garden bed, located in front of gazebo, on right flank walkway.

Section 5.2.3: Circular Fountain

Another feature we strongly recommend implementing is a large circular fountain with a raised basin, to increase stimulation to sound and touch. Through our research, we discovered that the koi pond was popular due to the moving water. Implementing a fountain could build upon the enjoyment of the koi pond area, by not only generating more sound stimulation, but allowing the residents to interact with the water and receive touch stimulation. A critical aspect of this design is its height; similar to the elevated garden bed, the fountain design allows for wheelchairs to easily fit underneath the basin and directly touch the water. *Figure 32* below illustrates a three-dimensional model of the circular fountain, as well as a potential version of this design, sold by Lunaform. The seven foot Smithsonian fountain pool, approximately $5000,

is the specific model that we believe best matches our design, although other options could be purchased and implemented.

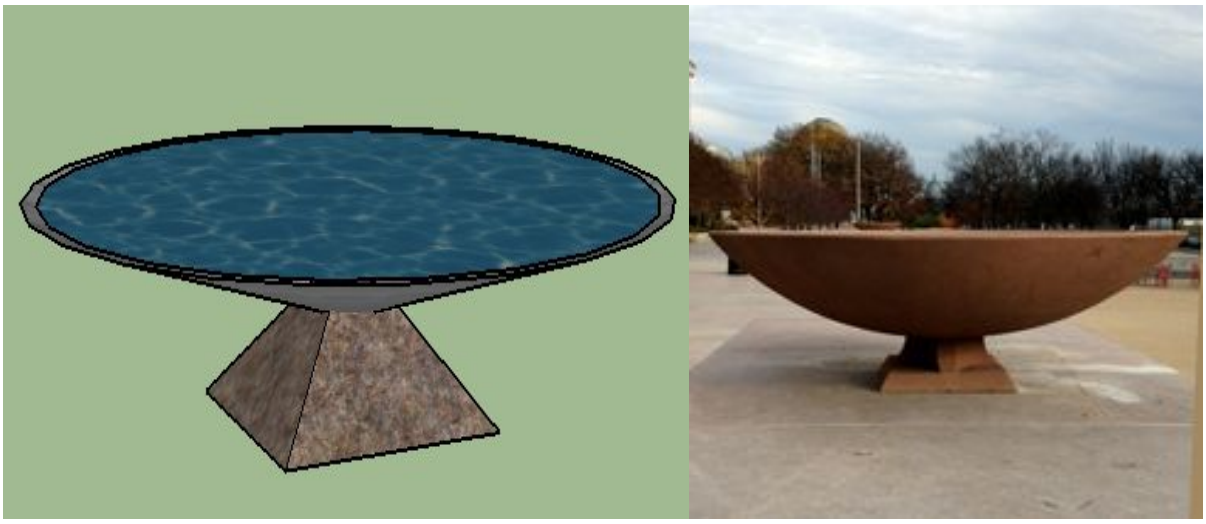


Figure 32: Circular fountain design. The left image is a three-dimensional rendering, while the right image is the 7' Smithsonian fountain pool.

In terms of placement, we believe that a circular fountain could be a strong centerpiece for the gazebo area. As seen in *Figure 33*, we recommend that the fountain be placed directly in front of the gazebo, on the other side of the walkway. This placement would allow the fountain to be accessed from 360°. It is important to note that this placement does require the removal of a small tree, and may subsequently require some form of concrete, asphalt, or graded base stone to stand on. This fountain will also require water, but can filled with simply a garden hose. In order to keep the water clean, an algae eliminating element should be added. One perfect example is the Submersible Dispenser, sold by Gardeners Supply Company, for $54.95. Lastly, this fountain contains a small pump to cycle the water, and would require a small amount of electricity, which could be generated by solar panels, as described below. For winterization, we recommend that the water be drained from the fountain to ensure the structural integrity of the bowl is not altered.

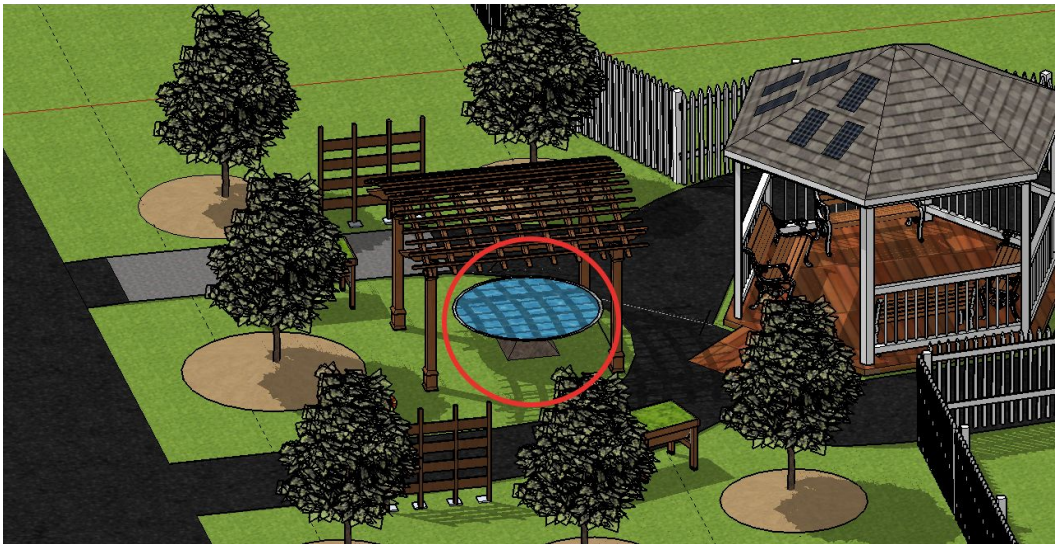


Figure 33: Potential placement for circular found, located in front of gazebo.

Section 5.2.4: Pergola

A common request from our surveys was shading. In order to accommodate this request, we recommended the installation of a pergola. A pergola is a simple, attractive, wooden shading feature that would work well with residents and plants. Although it has open roof sections, when placed correctly, the wooden boards create a shaded area throughout the day. If the pergola was not producing enough shade, colored cloth could be attached to the top to add color as well as shade. Ivy could also be grown on the pergola to increase shade, allowing the pergola to double as a hanging garden or even a vertical garden.

We suggest that the pergola be placed over the proposed fountain area, as seen in *Figure 34,* with a pathway of either asphalt or graded base stone around the fountain. This will create shade from the beams during morning and evening hours. With this, residents would be able to explore the outdoors more without risking too much sun exposure. The additional shade would allow residents to pleasantly enjoy the cool water from the fountain.

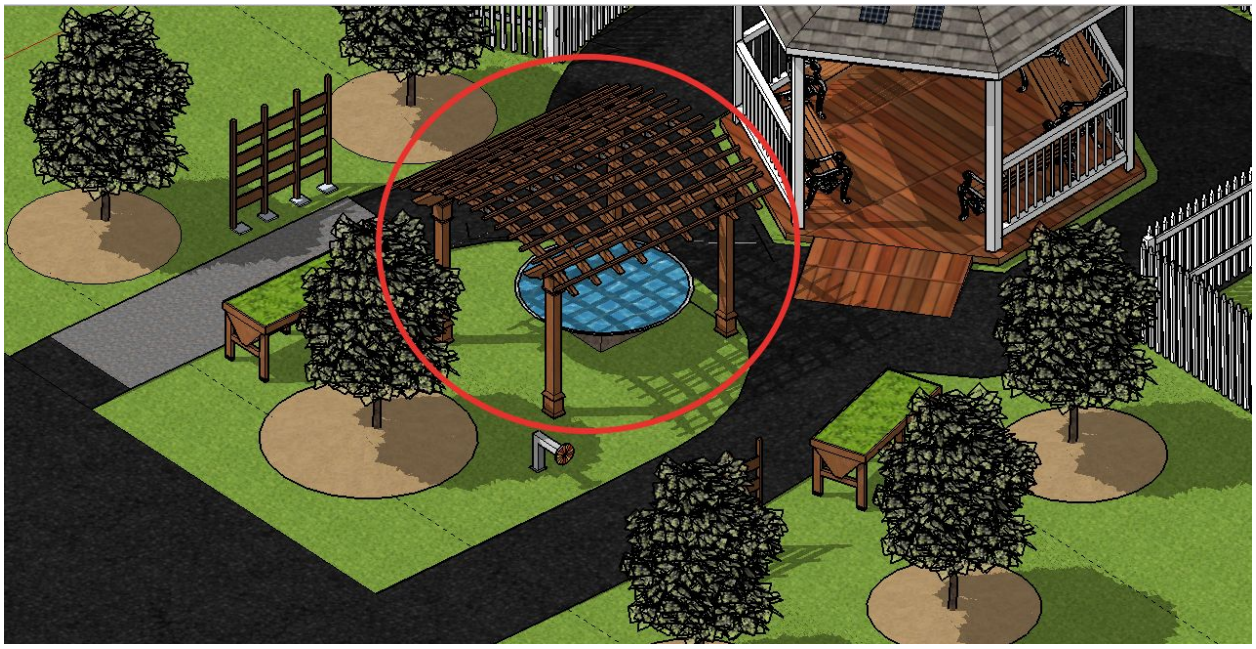


Figure 34: Potential placement for a pergola, above the fountain feature.

There are various kits and distributors we would recommend for the desired pergola. Most pergola kits start around a 8’ x 8’ covered area. The size we would recommend the pergola to be is 10’ x 12’. This will ensure enough space around the 7’ fountain. This should also be enough space to stay within the current pathways. The only concern would be extending the length towards the road as the tree currently there my be in the way. Cheaper options would be from Home Depot which include a 10’ x 12’ Wood Pergola, at $1,132. Another option from Home Depot is a Breeze Cedar 10’ x 12’ feet Pergola at $2,327. Although the price is much higher, the cedar wood would last much longer and be more resilient to weather and bugs. If looking beyond Home Depot, Fifthroom.com offers more pergola variety, but at a high cost of around $3000.

Section 5.2.5: Additional pathways

In addition to the above features, additional pathways may be desirable to increase accessibility. A primary area of focus is surrounding the circular fountain, which is currently only grass. As discussed previously, in order to ensure complete accessibility of the fountain, we

recommend adding a pathway around the fountain. We recommend approximately three yards of graded base stone, the same stone used to replace the bridge feature. Another three yards of graded base stone can be purchased from Pinard's Landscape Supply Yard, and would cost $78, with an extra $25 charge for delivery. It is recommended that a landscaping company be contacted to assist in the placement of the stone if any additional pathways are to be added.

Section 5.2.6: Solar Panels

A power source for the gazebo area is necessary for the functionality of the fountain feature, as well as allow other features requiring electricity to be implemented in the future. From our meeting with the maintenance staff (S. Gordon, personal communication, June, 2017), we learned that running electrical lines underground to the gazebo area would not be ideal, as it would require digging up the pavement to install the lines. As an alternative, we recommend solar panels as an environmentally friendly solution for the power requirement. As solar energy is becoming cheaper and more readily available, it is possible to use these in a small off-grid electrical system. Any installations of power systems needs to be done by professionals and approved by the local electric grid.

The gazebo roof would be the ideal location for solar panels because of its prolonged exposure to sunlight and its structural integrity, which should be more than capable to hold several 45 pound solar panels (S. Gordon, personal communications, June, 2017). *Figure 35*, seen below, is a potential placement for solar panels, though it is unlikely that nine panels would be required. An alternative to this placement would be in the space to the left of the Gazebo area and to the right of the oxygen tank area, as the panels would receive plenty of direct sunlight. The panels can be easily packed and stored during winter, to allow for the use of the space for snow removal. We strongly recommend that the energy generate by these solar panels only be used for small electrical applications, such as the pump inside the fountain, or potential lights around the gazebo or pergola. We strongly discourage these panels be used for ventilation or emergency needs, as the energy generated may not always be sufficient.

Figure 35: Example of small solar panels attached to gazebo roof

We recommend the use of different solar panels dependent on their placement. For a permanent placement, we recommend either the the HQST Polycrystalline Solar Panel or the Renogy Monocrystalline Solar Starter Kit with Wanderer for the roof of the gazebo. The HQST is a good starter panel, and is a cheaper solution, at around $135. However, we strongly recommend the Renogy starter set for the gazebo, as the kit includes attachment segments, a power controller, and wiring for battery connection, for $335. For temporary ground place solar panels, we recommend either the Boulder 100 Briefcase or the Nomad 28 solar panel, sold by Goal Zero. The Boulder is an easily movable and storable solar panel case for around $375. The Nomad is another easily transferable solar panel for around $250. A detailed description of these solar panels can be found in *Appendix M*.

To go along with the panels, Goal Zero offers power storage that allows easy access to using everyday products. This is only recommended if there is a desire for tablets or other high power required appliances in the future. The Yeti 150 and 400 are a clean battery that easily attaches to their solar panels for direct charging, but allow for other panels to be connected

through adapter cables. The Yeti 150 stores 150 Watt hours of charge for $200, while the Yeti 400 stores 400 Watt hours of charge for $460.

Section 5.2.7: Horticulture and vegetation

The most critical aspect of creating an effective sensory garden is proper plant selection. In order to create a comprehensive list of plants to include in our designs, it was important to consider climate, maintenance, and placement. To ensure stimulation of the five senses, it was also important to select plants that did not focus solely on sight. Unfortunately, sound was quite difficult to achieve due to the harsh winter conditions of New England; most auditory stimulating plants were grasses or bamboos that would not survive the first frost. Including in *Appendix N* is a compiled list of suggested plant species, composed for sight, touch, and smell/ taste stimulation. It is important to note that this list is only a loose suggestion for plant species, and includes plants that may not be readily available. An alternative to selecting plants directly from this list would be to visit local nurseries or hardware stores that sell plants. This course of action was taken for the plant selection of the vertical garden that we implemented. We visited a local hardware store and selected a variety of plant life. We decided this method was preferable to selecting plants from our list as it allowed us to immediately fill the vertical garden with plants, instead of waiting for deliveries. These selected plants can be seen in *Appendix O*. The primary focus when purchasing plants is to effectively encapsulate the aspects of a sensory garden through sensory stimulation. For this reason, a variety of herbs and small, colorful flowers were selected for our vertical garden.

Section 5.2.8: Conclusion

By successfully achieving our goal of designing an interactive space that appeals to cognitive growth and development, we hope to grant Seven Hills Pediatric Center the possibility of drastically improving their outdoor environment. Upon complete installation of the features we recommend, we hope to have created a space that fulfills the needs of SHPC residents, staff, and family members, as well as offering an additional recreational and educational resource to

the facility. Furthermore, we hope that the design allows SHPC residents to exceed the expectations of their cognitive, social, and physical developmental growth.

## References


AAIDD. (2010). Frequently Asked Questions on Intellectual Disability. Retrieved from https://aaidd.org/intellectual-disability/definition/faqs-on-intellectual-disability#.WSiKWGjys2x

About trimble. (2017). Retrieved from http://www.trimble.com/Corporate/About_at_Glance.aspx

Bowers, D. A. (2003). *INCORPORATING RESTORATIVE EXPERIENTIAL QUALITIES AND KEY LANDSCAPE ATTRIBUTES TO ENHANCE THE RESTORATIVE EXPERIENCE IN HEALING GARDENS WITHIN HEALTH CARE SETTINGS * ().Department of Horticulture and Landscape Architecture.

Bucholz, J. L., & Sheffler, J. L. (2009). Creating a warm and inclusive classroom environment: Planning for all children to feel welcome.*2*(4)

CDC. (2015, July 09). Developmental Disabilities. Retrieved from https://www.cdc.gov/ncbddd/developmentaldisabilities/facts.html

Center for Universal Design (1997). The Principles of Universal Design, Version 2.0. Raleigh, NC: North Carolina State University.

Dassault systemes. (2017). Retrieved from https://www.3ds.com/?gclid=CjwKEAjwytLKBRCX547gve7EsE4SJAD3IZV61VRL5ONDuryVSx_ozyww_cpsPan9Qj-VbApCA90QlhoCQs7w_wcB

Dispatch, R. M. (2012, June). 'Sensory garden' opens at center for disabled. Retrieved from http://www.dispatch.com/content/stories/local/2012/06/28/garden-of-delights.html

Dorsch, T., Richards, K. A., Swain, J., & Maxey, M. (2016). The Effect of an Outdoor Recreation Program on Individuals With Disabilities and their Family Members: A Case Study. *Therapeutic Recreation Journal,50*(2). doi:10.18666/trj-2016-v50-i2-6527

Elliot, T., Kurylo, M., & Rivera, P. (2002). *Handbook of positive psychology*

Elmansy, R.Empathic design: The most difficult simple approach to successful design. Retrieved from http://www.designorate.com/empathic-design-approach-to-successful-design/

Erickson-Hall Construction. (2017). Retrieved from http://www.ericksonhall.com/en/projects/educational/san-elijo-elementary-school-classroom-building-addition/

Fowler Jr., F. J. (1995). Improving survey question. (pp. 8-20)

Groves, J. F., Abts, L. R., & Goldberg, G. L. (2014). Using an engineering design process portfolio scoring rubric to structure online high school engineering education. *121st ASEE Annual Conference & Exposition.*

House with No Steps. (2015). Types of physical disabilities

Hussein, H. (2012). The influence of sensory gardens on the behaviour of children with special educational needs. *Procedia - Social and Behavioral Sciences, 38*, 343-354. doi:10.1016/j.sbspro.2012.03.356

IDEO. (2009) *Human-Centered Design Toolkit* - A Free Toolkit for NGOs and Social Enterprise

Kennedy, M. (2006). A guide to interview guides. Retrieved from https://msu.edu/user/mkennedy/digitaladvisor/Research/interviewing.htm

Langtree, I. (2016, June 04). Cognitive Disability: Information on Intellectual Disabilities. Retrieved from https://www.disabled-world.com/disability/types/cognitive/

Many Benefits of Sensory Garden. (2017). Retrieved from https://www.planetnatural.com/sensory-gardens/

Marcus, C. C., & Barnes, M. (1995). *Gardens in healthcare facilities: Uses, therapeutic benefits, and design recommendations*. Martinez, CA: The Center for Health Design Inc.

Marcus, C. C., & Barnes, M. (1999). *Healing gardens: Therapeutic benefits and design recommendations*. New York: John Wiley & Sons.

McLeod, S. (2015). Observation methods. Retrieved from https://www.simplypsychology.org/observation.html

National Center for Charitable Statistics. (2003, November). NPC Program Code List. Retrieved from http://nccsdataweb.urban.org/kbfiles/466/NPC-lookup.pdf

NSIP. People with Developmental and Cognitive Disabilities. Retrieved from http://www.serviceandinclusion.org/index.php?page=developmental

Padgett, D. K. (2008). *Qualitative methods in social work research* (2. ed. ed.). Los Angeles [u.a.]: Sage.

Pagliano, P. (2016). *Using A Multisensory Environment: A Practical Guide for Teachers*. ROUTLEDGE.

Parasuraman, A. (1991). *Marketing research* (2nd ed.) Addison Wesley Publishing Company.

Pedersen, C. (2013). *The sensory garden experience: A sensory enrichment design for the arizona school for the deaf and blind.* (). Arizona: The University of Arizona.

Quikrete (2017) *Setting Posts Without Mixing*. Retrieved from https://www.quikrete.com/athome/video-setting-posts.asp

Scale and proportion. (2017). Retrieved from https://network.aia.org/cran/home/wiki/scaleandproportion

Sensory Trust http://www.sensorytrust.org.uk (Assessed May 2017)

Seven Hills Foundation Inc. (2017). Retrieved from http://www.givingcommon.guidestar.org/FullPDF.aspx?OrgId=1115009

Seven Hills Pediatric Center. (2017). Retrieved from http://www.sevenhills.org/affiliates/seven-hills-pediatric-center

Smith, D., & Tyler, N. (2009). *Introduction to special education; making a difference, 7th ed*. Portland: Ringgold Inc.

Teach Engineering (2017). *Engineering Design Process*. Retrieved from https://www.teachengineering.org/k12engineering/designprocess#Create

United Nations General Assembly. (3 May 2008). Status of treaties in human laws; *Convention on the Rights of Persons with Disabilities,* New York.

*Urban green spaces and health.* (2016). Copenhagen: WHO Regional Office for Europe http://www.euro.who.int/__data/assets/pdf_file/0005/321971/Urban-green-spaces-and-health-review-evidence.pdf?ua=1

Weber, M. C. (2010). A New Look at Section 504 and the ADA in Special Education Cases. Retrieved from http://www-lexisnexis-com.ezproxy.wpi.edu/lnacui2api/results/shared/controller/permalink.do

*World report on disability*. (2011). Geneva: World health organization.http://www.who.int/disabilities/world_report/2011/report.pdf

# Appendices

## Appendix A: Principles of Universal Design

**PRINCIPLE ONE: Equitable Use**
The design is useful and marketable to people with diverse abilities.
**Guidelines:**

- **1a.** Provide the same means of use for all users: identical whenever possible; equivalent when not.
- **1b.** Avoid segregating or stigmatizing any users.
- **1c.** Provisions for privacy, security, and safety should be equally available to all users.
- **1d.** Make the design appealing to all users.

**PRINCIPLE TWO: Flexibility in Use**
The design accommodates a wide range of individual preferences and abilities.
**Guidelines:**

- **2a.** Provide choice in methods of use.
- **2b.** Accommodate right- or left-handed access and use.
- **2c.** Facilitate the user's accuracy and precision.
- **2d.** Provide adaptability to the user's pace.

**PRINCIPLE THREE: Simple and Intuitive Use**
Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
**Guidelines:**

- **3a.** Eliminate unnecessary complexity.
- **3b.** Be consistent with user expectations and intuition.
- **3c.** Accommodate a wide range of literacy and language skills.
- **3d.** Arrange information consistent with its importance.
- **3e.** Provide effective prompting and feedback during and after task completion.

**PRINCIPLE FOUR: Perceptible Information**
The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
**Guidelines:**

- **4a.** Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
- **4b.** Provide adequate contrast between essential information and its surroundings.
- **4c.** Maximize "legibility" of essential information.
- **4d.** Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
- **4e.** Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

**PRINCIPLE FIVE: Tolerance for Error**
The design minimizes hazards and the adverse consequences of accidental or unintended actions.
**Guidelines:**

- **5a.** Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
- **5b.** Provide warnings of hazards and errors.
- **5c.** Provide fail safe features.
- **5d.** Discourage unconscious action in tasks that require vigilance.

**PRINCIPLE SIX: Low Physical Effort**
The design can be used efficiently and comfortably and with a minimum of fatigue.
**Guidelines:**

- **6a.** Allow user to maintain a neutral body position.
- **6b.** Use reasonable operating forces.
- **6c.** Minimize repetitive actions.
- **6d.** Minimize sustained physical effort.

**PRINCIPLE SEVEN: Size and Space for Approach and Use**
Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.
**Guidelines:**

- **7a.** Provide a clear line of sight to important elements for any seated or standing user.
- **7b.** Make reach to all components comfortable for any seated or standing user.
- **7c.** Accommodate variations in hand and grip size.
- **7d.** Provide adequate space for the use of assistive devices or personal assistance.

**Principles and Guidelines taken from** (Center for Universal Design, 1997)

## Appendix B: Sensory Gardens

Affordance is the relationship between the environment and the user and the possibilities that the area can offer the user, which the possibilities can be intentional or unintentional (Hussein, 2012). Affordance can be split up into two categories: actualized and potential. Actualized affordances are perceptual experiences users may have when engaging in their environments. Potential affordance is different for every individual or group of people, depending on how their abilities, body shape, social needs and personal intentions match with the environmental feature. Both of these influence the design of a sensory garden in order to generate individual experiences. Actualized and potential affordances can each be further divided into positive and negative affordances (Hussein, 2012). These types are determined by the user depending on the quality of the features that can be perceived from the senses and are determined by the user's movements and their perceptions of the environment. This leads to a positive affordance when feeling satisfaction and appeal, while a negative affordance can come from feelings of avoidance, danger, or even fear.

Information is sense stimulating feature that can be gathered by the user and changes depending on the user's actions and senses (Hussein, 2012). Information that is received in a sensory garden can differ immensely from person to person based on their cognitive abilities. Information is ever changing depending on the user's movements (sitting, standing, and walking) and their senses (sight, hearing, taste, touch, and smell), and these changes are important for identifying, extracting and describing information relative to the user. Information pickup is how information is gathered by the user and interpreted (Hussein, 2012). Information pickup comes in two categories: exploratory and performatory. Exploratory allows users to discover new properties of the environment and their own capabilities. Performatory comes from the experiences learned from affordances and relates to actions directed towards objects or individuals within a setting. It is from these concepts that a sensory garden can be realized to its full potential, and possibly beyond for users.

## Appendix C: Sensory Garden Visits

| | Criterion 1: Accessibility and Safety | Criterion 2: Appeal to sight | Criterion 3: Appeal to sound | Criterion 4: Appeal to smell/ taste | Criterion 5: Appeal to touch |
|---|---|---|---|---|---|
| Location: | | | | | |
| Saint Vincent Hospital | 5<br>Indoor space for hospital patients to experience nature. Very safe and accessible. | 3<br>Designed to replicate an outdoor setting, including trees and other plant life. | 4<br>Large waterfall running throughout the middle of the design. | 1<br>No appeal to smell or taste evident | 1<br>No appeal to touch evident |
| Watertown Riverfront Park and Braille Trail | 3<br>Prescriptively designed for visually impaired individuals, otherwise lacking in overall accessibility | 2<br>As this trail was designed for visually impaired individuals, sight is not an important aspect | 2<br>Located next to a river | 1<br>No appeal to smell or taste evident | 5<br>Ropes line the path to guide visually impaired individuals, along with differently shaped blocks to distinguish different landmarks |
| Howard Ulfelder, MD Healing Garden (Mass Gen, Boston) | 4<br>Small outdoor space for patients, easily accessible and very safe. | 5<br>Located on the eight floor of Massachusetts General Hospital in Boston, this small outdoor healing garden features an incredible view and some plant life. | 2<br>Small water feature, some ambient noise from city streets detectable | 1<br>No appeal to smell or taste evident | 1<br>No appeal to touch evident |
| Ferguson Greenhouse (Wellesley College) | 2<br>Not very accessible. | 5<br>The primary purpose of this greenhouse is the conservation and observation of various plant life. Sight was the focal point of this greenhouse. | 1<br>No appeal to sound evident | 2<br>Smell is barely | 1<br>No appeal to touch evident |

| | | | | | |
|---|---|---|---|---|---|
| Arnold Arboretum | 3<br>Accessibily is not a priority. | 4<br>Focused on displaying a large spectrum of different tree species, sight is an important aspect | 2<br>Large outdoor tree santuary, some water features, as well as wildlife are detectable | 1<br>No appeal to smell or taste evident | 2<br>Different species of trees have interesting textures |
| Tower Hill Botanic Gardens | 5<br>Universal Garden designed specifically for accessibility and safety. | 5<br>Home to a large variety of plant species, appearance is a key feature. Vibrant colors and types of plants are a main focus. | 4<br>Several water features, bird feeders | 4<br>Specific plant species grown to smell good and to cook with/ eat. | 5<br>Specific plant species grown to stimulate touch, plant beds designed for easy access to touch |
| Cedarcrest Center for Children with Disabilities | 5<br>Specially designed playground and walkway areas encapsulate all principles of accessibility and safety | 4<br>Brightly colored playground area, various plant life | 5<br>Musical instrument features, bird feeders | 1<br>No appeal to smell or taste evident | 4<br>Interactive panels |
| | | | | | |
| | Accessibility and Safety Guidelines | Appeal to sight scale | Appeal to sound scale | Appeal to smell/ taste scale | Appeal to touch scale |
| | 1 - Unacceptable: Accessibility and safety were not evident at all. | 1- No appeal: Sight is not appealed to at all. | 1- No appeal: Sound is not appealed to at all. | 1- No appeal: Smell and taste are not appealed to at all. | 1- No appeal: Touch is not appealed to at all. |
| | 2 - Poor: Accessibility and safety is barely evident. | 2 - Little appeal: Sight has very little appeal, and is for the most part ignored. | 2 - Little appeal: Sound has very little appeal, and is for the most part ignored. | 2 - Little appeal: Smell and taste have very little appeal, and are for the most part ignored. | 2 - Little appeal: Touch has very little appeal, and is for the most part ignored. |

| | | | | | |
|---|---|---|---|---|---|
| | 3 - Acceptable: Accessibility and safety are evident in the space, but are not primary focuses. | 3- Some appeal: Sight has some appeal, but is not very evident | 3- Some appeal: Sound has some appeal, but is not very evident | 3- Some appeal: Smell and taste have some appeal, but are not very evident | 3- Some appeal: Touch has some appeal, but is not very evident |
| | 4 - Good: Accessibility and safety are evident, and the space incorporates these principles well. | 4 - Strong appeal: Sight has a strong appeal, and is an obviously targeted sense. | 4 - Strong appeal: Sound has a strong appeal, and is an obviously targeted sense. | 4 - Strong appeal: Smell and taste have a strong appeal, and are obviously targeted senses. | 4 - Strong appeal: Touch has a strong appeal, and is an obviously targeted sense. |
| | 5 - Excellent: Accessibility and safety are clearly evident, and the space was designed around these principles. | 5 - Excellent appeal: Sight is a primary focus, and is highly appealing. | 5 - Excellent appeal: Sound is a primary focus, and is highly appealing. | 5 - Excellent appeal: Smell and taste are a primary focus, and are highly appealing. | 5 - Excellent appeal: Touch is a primary focus, and is highly appealing. |

# Appendix D: Staff Surveys

## Designing an Outdoor Interactive Space

We are a group of students from Worcester Polytechnic Institute (WPI). This summer we will be working with Seven Hills Pediatric Center to develop landscape architectural designs (i.e. sensory gardens) for their residents, so that the residents have a more accommodating and developed outdoor environment to use both recreationally and educationally. We strongly believe this project will transform the community at Seven Hills Pediatric Center, and also provide other special education facilities with the appropriate information for them to develop a similar space. Your participation in this survey is completely voluntary. Please remember that your answers will remain confidential. No names will appear on any of the project reports or publications. This is an independent research project brought to us by Seven Hills Pediatric Center and WPI; your participation is greatly appreciated and will assist our team to determine design criteria and ideas for the project. If interested, a copy of our research/results can be provided at the conclusion of the project. If you would like any additional information, please feel free to contact us at wcpc-e17@wpi.edu. You can also speak with our faculty advisors, Corey Dehner (cdehner@wpi.edu) and Derren Rosbach (drosbach@wpi.edu).

* Required

### This survey should not take longer than 15 minutes. All of your answers will be of value to the completion of our project. Thanks for your participation!

1. **What is your position at Seven Hills Pediatric Center?** *

2. **Please give a brief description of your responsibilities.**

3. **How often do you bring the residents to the outdoor areas? (assuming ideal weather conditions)**
   *Check all that apply.*

   - [ ] Every day
   - [ ] 1-5 times a week
   - [ ] 1-5 times a month
   - [ ] Not able to

4. **Which outdoor areas do you use the most with the residents? (i.e. Gazebo area, Walmart plaza, Koi pond area, etc.)**

5. **What do you like about these areas?**

6. **What would you like the outdoor area to provide for residents?**

7. **Rank the following senses in order of importance that you believe the residents would value experiencing outdoors (1 being most important).**

   *Check all that apply.*

   - [ ] Smell
   - [ ] Touch
   - [ ] Hearing
   - [ ] Sight
   - [ ] Taste

## Designs

Rank each of the following potential additions from 1-6 (1 being most important, 6 being least important).

8. **Fountain or Water Fixture**

*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Fountain/Water Feature | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

9. **Vertical Gardens**


*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Vertical Gardens | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

10. **Raised Garden Beds**

*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Raised Garden Beds | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

11. **Raisable Flower Pots/Bird Feeders**

*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Raisable Flower Pots/Bird Feeders | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

12. **Auditory Feature**

*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Auditory feature | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

13. **Educational Feature**


*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Educational feature | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

14. **Do you have any concerns about these types of features for the residents?**

_____

_____

_____

_____

_____

15. **Aside from the above features, do you have any other ideas for the outdoor space that could benefit the residents, visitors, and yourselves?**

## Further discussion

16. **If you have any additional comments you would like to add, feel free to do so in the space below.**

17. **For the next several weeks, our research group will be meeting with a small panel to discuss our design ideas and receive feedback. Would you like to potentially take part in this panel? If you have any further questions or concerns, feel free to email us at wcpc-e17@wpi.edu.**

*Mark only one oval.*

- Yes
- No

Powered by Google Forms

# Appendix E: Family Surveys

## Designing an Outdoor Interactive Space

We are a group of students from Worcester Polytechnic Institute (WPI). This summer we will be working with Seven Hills Pediatric Center to develop landscape architectural designs (i.e. sensory gardens) for their residents, so that the residents have a more accommodating and developed outdoor environment to use both recreationally and educationally. We strongly believe this project will transform the community at Seven Hills Pediatric Center, and also provide other special education facilities with the appropriate information for them to develop a similar space. Your participation in this survey is completely voluntary. Please remember that your answers will remain confidential. No names will appear on any of the project reports or publications. This is an independent research project brought to us by Seven Hills Pediatric Center and WPI; your participation is greatly appreciated and will assist our team to determine design criteria and ideas for the project. If interested, a copy of our research/results can be provided at the conclusion of the project. If you would like any additional information, please feel free to contact us at wcpc-e17@wpi.edu. You can also speak with our faculty advisors, Corey Dehner (cdehner@wpi.edu) and Derren Rosbach (drosbach@wpi.edu).

* Required

### This survey should not take longer than 15 minutes. All of your answers will be of value to the completion of our project. Thanks for your participation!

### Describe your family member in the following sections.

1. **Age of the your family member?**
   *Mark only one oval.*

   - 1-10
   - 11-20
   - 21-30
   - 31-40
   - 41-50
   - 51-60

2. **How long has he/she been at Seven Hills?**

3. **On average, how often do you visit your family member?**

4. **How often do you bring your family member to the outdoor areas? (assuming ideal weather conditions)**
*Check all that apply.*

- [ ] Every day
- [ ] 1-5 times a week
- [ ] 1-5 times a month
- [ ] Not able to

5. **Which outdoor areas do you use the most with your family member? (i.e. Gazebo area, Walmart plaza, Koi pond area, etc.)**

6. **What features would encourage you and your family member to use the outdoor space more?**

7. **Rank the following senses in order of importance that you believe your family member would enjoy most experiencing outdoors (1 being most important).**
*Check all that apply.*

- [ ] Smell
- [ ] Touch
- [ ] Hearing
- [ ] Sight
- [ ] Taste

## Design

Rank each of the following potential additions from 1-6 (1 being most important, 6 being least important)

8. **Fountain or Water Fixture**

*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Fountain/Water Feature | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

9. **Vertical Gardens**


*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Vertical Gardens | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

10. **Raised Garden Beds**

*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Raised Garden Beds | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

11. **Raisable Flower Pots/Bird Feeders**

*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Raisable Flower Pots/Bird Feeders | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

12. **Auditory Feature**

*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Auditory Feature | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

13. **Educational Feature**


*Mark only one oval per row.*

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Educational Feature | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

14. **Do you have any concerns about these types of features for your family member?**

15. **Aside from the above features, do you have any other ideas for the outdoor space that could benefit the family members and yourselves?**

## Further discussion

16. **If you have any additional comments you would like to add, feel free to do so in the space below.**

17. **For the next several weeks, our research group will be meeting with a small panel to discuss our design ideas and receive feedback. Would you like to potentially take part in this panel? If you have any further questions or concerns, feel free to email us at wcpc-e17@wpi.edu.** *

*Mark only one oval.*

- Yes
- No

Powered by Google Forms

## Appendix F: Interview Questions

Interview Questions for Staff Members of Seven Hills Pediatric

1. What is your position at Seven Hills Pediatric Center?
2. What does your typical day look like?
3. How much time is spent outdoors when weather permits?
4. When you do go outside, where do you normally go and what are some activities that you do with the residents?
5. When outside, what features tend to be utilized most?
    a. What improvements could be made to other features to increase their usage?
    b. Are there any broken or otherwise unusable features?
6. What senses are most stimulated by the current outdoor space?
    a. Is there anything from the classrooms that we could move to the outdoors to help with stimulation?
7. We are considering implementing a sensory garden design, with features such as a fountain, vertical gardens, raised flower beds, etc. How do you think the residents would benefit from the addition of these features?
8. Would the residents/staff benefit from educational signage that would include information about the garden, the plants, and other features?
    a. What other educational features could be added to the space?
9. Do you have any additional ideas that could help improve the outdoor spaces to make it more beneficial for residents, family members, and other staff?

10. Over the next few weeks, our research group will be meeting with a small panel to discuss our design ideas and receive feedback. Would you like to be considered to take part in this panel?

## Appendix G: Observation Notes

Observation Notes 6-1-17

Types of Classes: Primary (ages 3-7), Elementary (7-10), Secondary (10-14), and Upper (14-18)

Secondary Class Observations

- Walker with clicker in wheels
- For those with more mobility, wore specific shoes for walking support
- Eyegaze technology
    - Activated through eye contact/can make selection with eyes
    - Can also be activated with touch
- One on one care when going outside
- Due to respiratory problems, it can be difficult to take some students out

Play Room

- Has a mat so students can spread out/stretch
- Has overhead mechanical lift
    - Lifts students out of their wheelchair (only needs one person to do this)
    - These are available in every room
- Mirror tiles on the ceiling so they can see themselves when they're on the floor
- Has laser lights
- Have various types of switches
    - Switches can be plugged into toys/other objects to activate them

Upper Class

- Hand over hand and hand under hand technique
- Auditory and visual aspects
    - Chimes and contrasts in color are important
- Incorporate senses into the classroom
    - Apple example
- Voice output devices are used specifically in this class
- Has a fish tank
    - Students picked out fish

Other notes

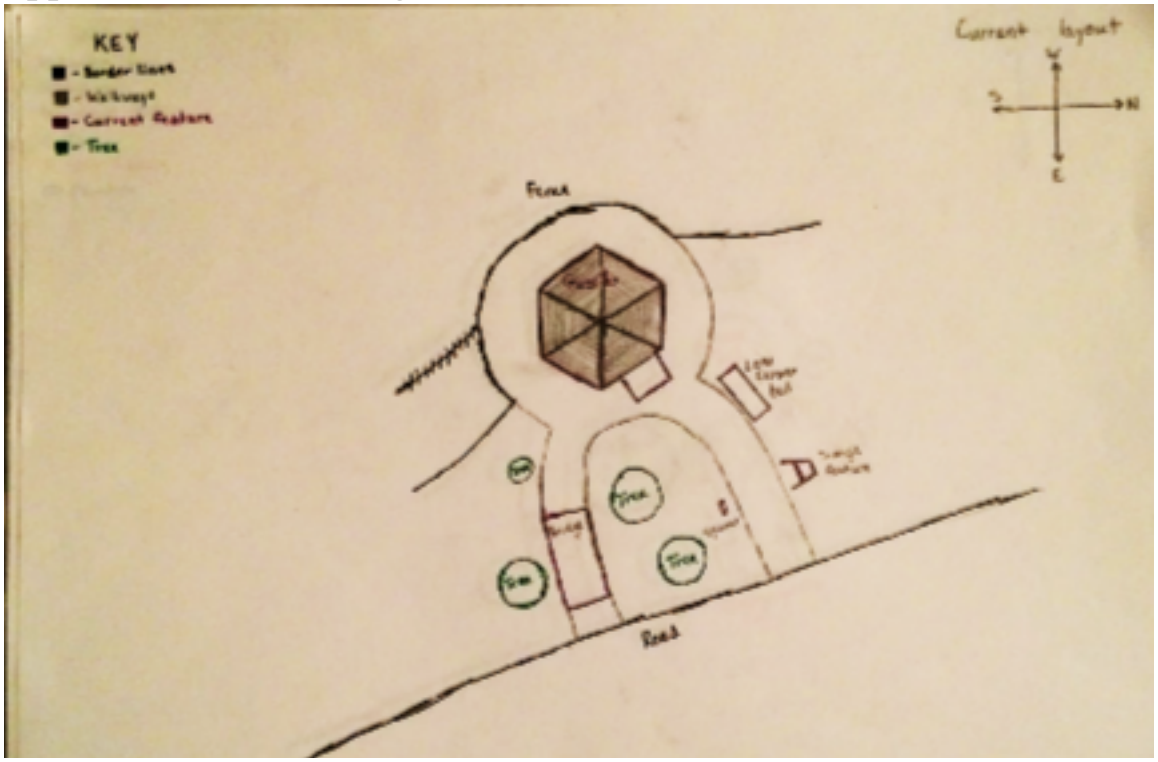
- 82 total residents
    - 36 are in schooling
    - 36 are in adult care
    - Others are temp residents
- Around 230 staff members
- Have volunteers from local high schools; both private and public
- 22 is the max age for schooling

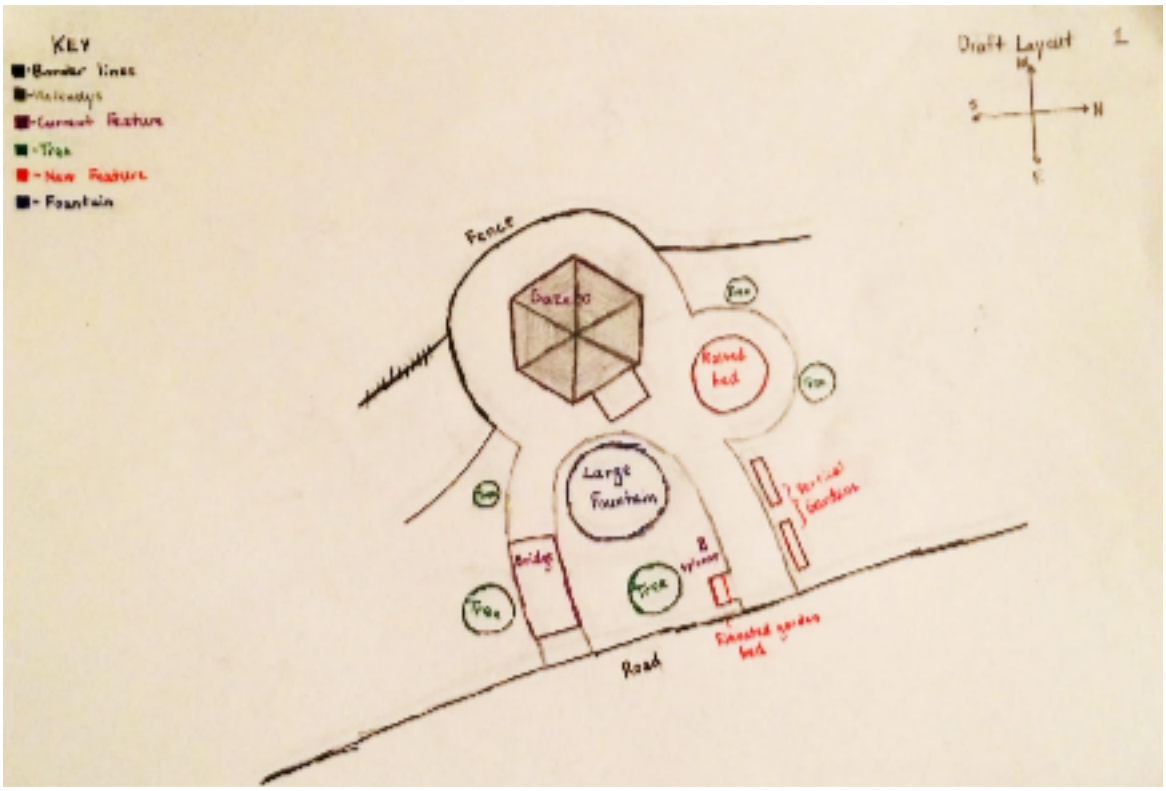
- There's a range of four years or less per class

Possible Implementations/Desires

- Gardening option
- Water
    - Running water is excellent
        - Sight
        - Hearing
        - Touch
        - Could have a smell thing implemented
- Smell thing
- Fixing the bridge and other features that already exist
    - The chimes are both too low and too heavy to be used effectively for the students
    - The triangles need to be raised
    - ***BRIDGE NEEDS REDESIGNING AND REBUILDING***
- Gazebo area is most used area
    - Shade of gazebo
    - Very close to the entrance of building
        - Good incase of emergency
    - Trees and shade and path make for a good area
- Benefit concert idea
    - need to find a venue
    - Need permission of people in charge
        - Would need to get word out

## Appendix H: 2D Drawings



## Appendix I: 3D Rendering

Initial Layout Rendering:

Finalize Layout Rendering:

## Appendix J: Sensory Garden Trait Criteria

Our garden trait criteria:

| | |
|---|---|
| Accessibility/Safety | |
| Size<br>Compared to SHPC available space/compared to other gardens surveyed | |
| Location<br>Indoor, outdoor, address, public, institutional | |
| Features Involving Sensations<br>Auditory, olfactory, tactile stimulants | |
| Psychological or Social Aspects<br>Openness, peaceful/sense of escape | |
| Visual qualities relating to more than plant materials<br>Attractive landscape design, views, textual contrast/quality, differing shapes/sizes, | |
| Practical Features<br>Seating, maintenance, water features/cost, pathways | |
| Visitor Demographics | |
| Trees, Plants, and Animals<br>Flowers, colors, greenery, seasonal changes | |
| Additional Features | |

University of California Berkeley Sample Criteria

**TABLE 10–4**

***Percent of Respondents Who Named These Qualities as Helpful In Attaining a Mood Change***

| | Percent |
|---|---|
| Trees and plants | 69 |
| flowers, colors, greenery, heritage trees, being in nature, seasonal changes | |
| Features involving auditory, olfactory, or tactile sensations | 58 |
| birds/squirrels, wind/fresh air, water, quiet, light/sun, shade, fragrances | |
| Psychological or social aspects | 50 |
| peaceful, escape from work, openness/large, privacy/secret places, oasis, companionship, watching others, knowing it is here | |
| Visual qualities relating to more than plant materials | 26 |
| attractive landscape design, views, variety of elements, textural contrast/quality, differing shapes/sizes | |
| Practical features | 17 |
| seating, well maintained, accessibility, vending machines, smoking allowed, pathways | |
| No answer or "don't know" | 8 |

(Number of respondents: 143)

## University of Arizona Sample Criteria:

| | |
|---|---|
| **Acoustics**<br>**Auditory cues, Elemental Features, Traffic noise, Acoustics, Reverberation** | |
| **Light and Color**<br>**Colors, Contrast, Glare, Shadows** | |
| **Mobility and Proximity**<br>**Linear paths, Wide sidewalks, Open views, Hand rails** | |
| **Space and Proximity**<br>**Water features, Element accessibility, Plant interaction, Site accessibility** | |
| **Sensory Reach**<br>**Tactile stimulation, Spatial awareness** | |

**Appendix K:** Price analysis for materials of a single vertical garden

| Materials | Price | Seller |
|---|---|---|
| 4”x4”x8’ Pressure Treated Pine Posts (x4) | $35.68 | Home Depot |
| 2”x6”x8’ Pressure Treated Pine Boards (x4) | $25.48 | Home Depot |
| Mending Plate (x16) | $31.68 | Home Depot |
| 1LB 3” Wood Screws (Phillips Head) | $8.38 | Home Depot |
| Exterior Semi-Gloss Paint (White) | $33.98 | Lowes |
| 5-Pc Roller Kit | $12.98 | Lowes |
| Additional Brushes | $6.38 | Lowes |
| Fast Setting Concrete mix (x4) | $15.92 | Home Depot |
| 5 Gallon Bucket (x4) | $11.88 | Home Depot |
| Vertical Wall Planters (x12) | $227.22 | Amazon.com |
| Various Plants | $150 | Amazon.com |
| **TOTAL** | $559.58 | |

## Appendix L: Cost Analysis of Future Fundraising

| **Feature** | **Price** | **Seller** |
|---|---|---|
| VegTrug Elevated Garden (x2) | $440 | Gardeners Supply Company |
| 7’ Smithsonian Fountain Pool | $5,000 | Lunaform |
| 10’ by 12’ Cedar Pergola | $1,434 | Home Depot |
| Renogy 200 Watt 12 Volt Monocrystalline Solar Starter Kit | $314 | Amazon |
| Vertical Garden (x2) | $930 | Various Vendors |
| Graded Base (4 yards) | $152 | Pinards Landscape Supply Yard |
| **TOTAL** | $8,270 | |

## Appendix M: Solar Panel analysis

| Name | Placement | Wattage | Voltage | Price | Retailer | Additional comments |
|---|---|---|---|---|---|---|
| | | | | | | |
| HQST Polycrystalline Solar Panel | Gazebo roof | 100 Watts | 12 Volts | $135 | Amazon | Good starter panel, low cost |
| Renogy Monocrystalline Solar Starter Kit with Wanderer | Gazebo roof | 200 Watts | 12 Volts | $335 | Amazon | Includes attachment segments, a power controller, and wiring for battery connection |
| Boulder 100 Briefcase | Ground | 100 Watts | 18-22 Volts | $375 | Goal Zero | |
| Nomad 28 | Ground | 28 Watts | 18-22 Volts | $250 | Goal Zero | |

**Appendix N:** Suggested horticulture and plant life. Note that these are only suggestions, and that this list is only a small sample of potential plant species that would suit a sensory garden well.

| Sight | | | | | | |
|---|---|---|---|---|---|---|
| **Plant name** | **Rationale behind selection** | **Perennial or Annual** | **Sunlight requirements** | **Bloom time** | **Cost** | **Other comments** |
| Sunflowers, *Helianthus annuus* | Bright color, easily identifiable | Annual | Full sun | Summer | Under $5 | Attracts birds, attracts butterflies, edible seeds |
| Marigolds, Tagetes | Hardy, good color | Annual | Full sun | Spring, Summer, Fall | Under $20 | |
| Tulips | Beautiful color | Annual | Full sun, partial sun | Spring, Summer, Fall | Bulbs under $20 | Vibrant color, but gone quickly |
| Swiss Chard 'Bright Lights' | Vibrant color, taste | Somewhat perennial | Full sun, partial sun | Summer | Under $10 | Easy to grow, edible |
| Chameleon plant, *Houttuynia cordata* | Pink and green colors | Perennial | Full sun, partial sun | | | Highly invasive, good ground cover |
| Cosmos | Color | Somewhat perennial | Full sun | Summer, Fall | Under $10 | Attracts birds, attracts butterflies |
| Phlox | Ground cover, color | Perennial | Full sun, partial sun | Spring, Summer | Under $10 | Attracts birds, attracts butterflies, good ground cover |
| Snowmound spirea | Color | Perennial | Full sun, partial sun | Spring | $20 - $45, large plant | |
| Hydrangeas | Color | Perennial | Full sun, partial sun | Summer, Fall | $20 - $45, large plant | |
| Wisteria | Aromatic, beautiful | Perennial | Full sun, partial sun | Spring | Under $50 | Avoid Asian species, very invasive |
| Lilies | Color | Perennial | Full sun, partial sun | Spring, Summer, Fall | Under $30 | |
| Gentian Sage, Salvia patens | Color, unique flower shape | Perennial, annual in cold climates | Full sun | Summer, Fall | Under $20 | |
| Star of Persia, *Allium christophii* | Unique flower shape | Perennial | Full sun | Spring, Summer | Under $30 | |
| Night Sky Petunia | Amazing color | Annual | Full sun | Summer | Depends on availability | |
| * Superbells Lemon Slice | Color | Annual | Full sun, partial sun | Spring, Summer, Fall | Under $10 | |
| * Ageratum Cloud Nine blue | Color | Annual | Full sun | Summer | Under $10 | |
| * Timeless Pink Geranium | Color | Annual | Full sun | Spring, Summer | Under $10 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| * Supertunia Vista Bubblegum | Color | Annual | Full sun, partial sun | Spring, Summer, Fall | Under $10 | |
| * Angelface Wedgewood Blue | Color | Annual | Full sun | Spring, Summer | Under $10 | |

* - Indicates plants utilization in vertical garden

| Smell | | | | | | |
|---|---|---|---|---|---|---|
| **Plant name** | **Rationale behind selection** | **Perennial or Annual** | **Sunlight requirements** | **Bloom time** | **Cost** | **Other comments** |
| Lavender | Aromatic | Perennial | Full sun | - | Under $10 | |
| Chocolate cosmos, *Cosmos atrosanguineus* | Strong chocolate smell | Perennial | Full sun | Summer | Under $20 | Hard to find currently |
| Thyme | Aromatic, cooking aspects | Perennial | Full sun, partial sun | - | Under $20 | Best to buy plants, not seeds |
| Basil | Aromatic, cooking aspects | Annual | Full sun | - | Under $10 | |
| Honeysuckle | Aromatic | Perennial | Full sun, partial sun | Summer | Under $20 | Attract butterflies, birds |
| Wisteria | Aromatic, beautiful | Perennial | Full sun, partial sun | Spring | Under $40 | Avoid Asian species, very invasive |
| * Peppermint | Aromatic | Perennial | Full sun, partial sun | - | Under $10 | |
| * Oregano | Aromatic | Perennial | Full sun, partial sun | - | Under $10 | |
| * Rosemary | Aromatic | Perennial | Full sun, partial sun | - | Under $10 | |
| * Chocolate Mint | Strong chocolate and mint smell | Perennial | Full sun, partial sun | - | Under $10 | |
| * Lemon Balm | Strong lemon smell | Perennial | Full sun | - | Under $10 | |

* - Indicates plants utilization in vertical garden

| Taste | | | | | | |
|---|---|---|---|---|---|---|
| **Plant name** | **Rationale behind selection** | **Perennial or Annual** | **Sunlight requirements** | **Bloom time** | **Cost** | **Other comments** |
| Mint | Aromatic, good for cooking | Perennial | Full sun | - | Under $10 | Garlic chives |
| Chives | Aromatic, good for cooking | Perennial | Full sun | - | Under $10 | Northeaster variety recommended |
| Strawberries | Tasty! | Perennial | Full sun | Day-Neutral, Everbearer, or Junebearer | Under $30 | |
| Raspberries | Tasty! | Perennial | Full sun | Summer-fruiting or ever-bearing | Under $20 | Low Bearing variety preferred |
| Blueberries | Tasty! | Perennial | Full sun | Late July to mid August. | | Easy to grow, edible |
| Chard | Vibrant color, taste | Somewhat perennial | Full sun, partial sun | Summer | Under $10 | |
| Tomatoes | Tasty! | Annual | Full sun | Late summer | | Best to buy plants, not seeds |
| Thyme | Aromatic, cooking aspects | Perennial | Full sun, partial sun | - | Under $20 | |
| Basil | Aromatic, cooking aspects | Annual | Full sun | - | Under $20 | |
| * Asparagus | Touch, taste | Perennial | Full sun | Spring | Under $10 | |

* - Indicates plants utilization in vertical garden

| Touch | | | | | | |
|---|---|---|---|---|---|---|
| **Plant name** | **Rationale behind selection** | **Perennial or Annual** | **Sunlight requirements** | **Bloom time** | **Cost** | **Other comments** |
| Lamb's Ear, *Stachys byzantina* | Very soft to the touch | Perennial | Full sun | Spring, summer | | Can spread aggressively |
| *Fothergilla gardenii* | Soft touch | Perennial | Full sun, partial sun | Spring | | |
| Silver sage, *Salvia argentea* | Soft touch, edible | Perennial | Full Sun | - | Under $10 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Jerusalem sage, *Phlomis fruticosa* | Soft touch | Perennial | Full Sun | - | Under $10 | |
| Jewelweed | Plant pods pop! | Annual | Partial sun, shade | Summer, fall | | |
| Mexican feather grass, *Stipa tenuissima* | Soft to touch, | | | | | |

Note: A majority of the smell stimulating plants can stimulate touch as well, as touching the leaves and then smelling can create a stronger aroma.

Note: Mosses and grass can also be used to stimulate touch, and come in a large variety.

## Appendix O: Plants Currently In Place

| Plant name | Sense(s) appealed to |
|---|---|
| Superbells Lemon Slice | Sight |
| Ageratum Cloud Nine blue | Sight |
| Timeless Pink Geranium | Sight |
| Supertunia Vista Bubblegum | Sight |
| Angelface Wedgewood Blue | Sight |
| Ellagance Lavender | Smell, Sight |
| Dill | Touch |
| Asparagus | Touch, Taste |
| Peppermint | Touch, Smell |
| Lavender | Smell |
| Greek Oregano | Smell |
| Lemon Balm | Smell |
| Sweet Mint | Smell |
| Rosemary | Smell |
| Hot and Spicy Oregano | Smell |
| Chocolate Mint | Smell |