ABSTRACT

Title of Document:	MAXIMIZING LANDSCAPE PERFORMANCE AT ADVENTIST HOSPITAL: HEALING THE PEOPLE, HEALING SLIGO CREEK
	George Sorvalis, Masters of Landscape Architecture, 2016
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This paper answers the question of whether a design intervention on Washington Adventist Hospital's Takoma Park campus can combine stormwater Best Management Practices with outdoor healing spaces, to improve the health of the local creek (Sligo Creek) while creating a restorative environment for the hospital community. To improve the health of Sligo Creek, a campus-wide stormwater analysis was undertaken, in addition to an intervention-site-specific stormwater analysis, and a literature review of stormwater best management practices. To create a healing garden, a literature review of healing gardens was undertaken, in addition to a campus-wide site analysis, to uncover the most ideally suited site to create a restorative environment.

MAXIMIZING LANDSCAPE PERFORMANCE AT ADVENTIST HOSPITAL: HEALING THE PEOPLE, HEALING SLIGO CREEK

By

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CHAPTER 1: INTRODUCTION

1.1 Adventist Hospital

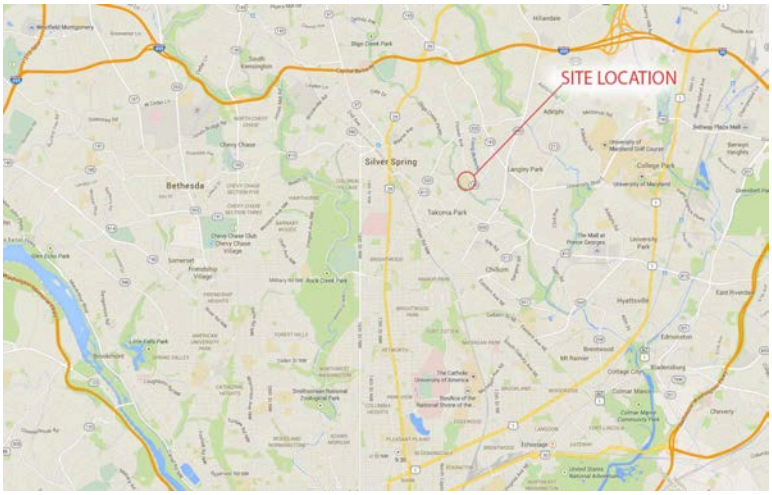


Figure 1.1 – "Adventist Hospital Site Location." By Author

Adventist Hospital's official name is Adventist HealthCare Washington Adventist Hospital, and is a 252-bed acute-care facility located in Takoma Park, Maryland. The hospital was opened in 1907 and is Montgomery County, Maryland's first cardiac center.[1] Inside the hospital, cardiac and vascular care, cancer care, orthopedic care, and emergency care are performed.[2] Outside the hospital, the landscape provides parking for staff and visitors, shipping/receiving bays and drives for needed services, and a stormwater system of drains, pipes and outlets that direct stormwater to Sligo Creek. All healthcare services are performed inside the hospital, with no healthcare functions, or stormwater Best Management Practices provided by the outdoor landscape.

1.2 Stormwater Impacts

Stormwater is a growing issue especially in urban areas that have a great deal of impervious surfaces. Rapid population increases — accompanied by intensified industrial, commercial, and residential development— have led to the pollution of surface

[1] "Adventist HealthCare."
[2] "2013-CHNA-WAH.pdf."

waters by fertilizers, insecticides, motor oil, toxic landfill leachates, and feedlot waste.[3] At the same time that water pollution and releases of sewage have increased, water consumption has also increased, thus reducing the flows available for the dilution of wastes.[4]

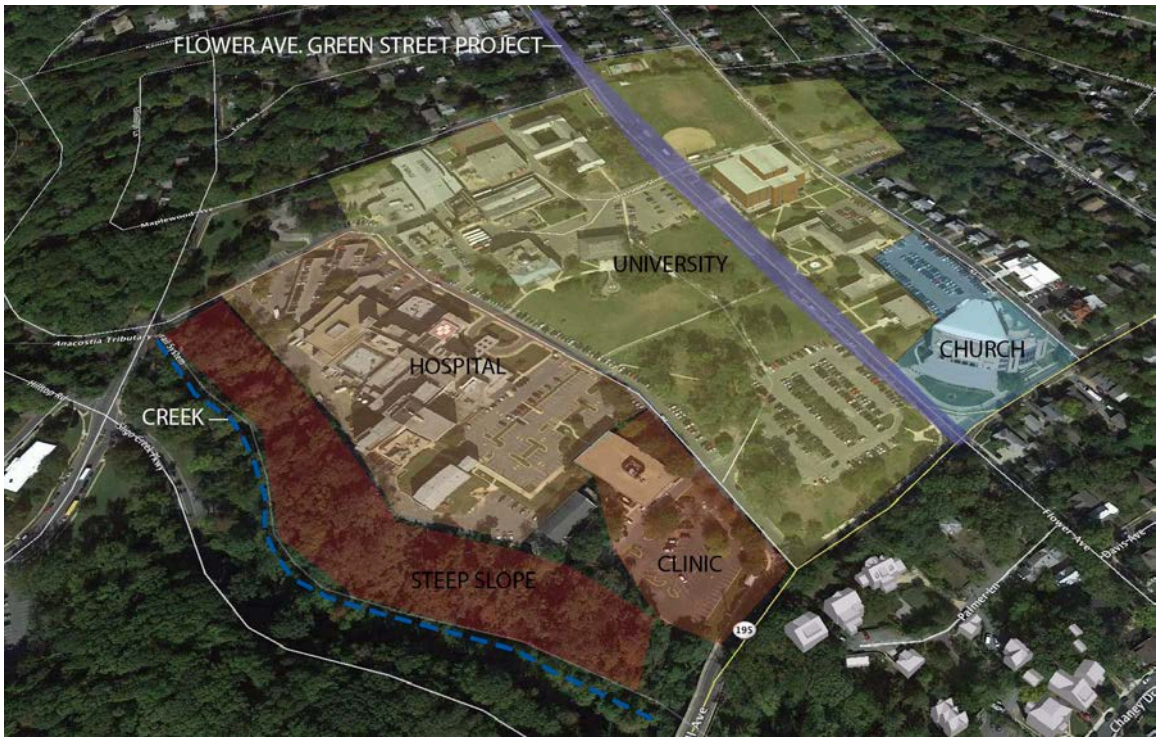


Figure 1.2 "Aerial View of Site." By Author

Based on an analysis of Google Earth, 80% of Adventist Hospital's campus is impervious consisting of rooftops and parking lots, and pitches towards a steep slope leading directly down to Sligo Creek. Based on the slope and impervious surfaces, the campus delivers a great deal of stormwater to the creek during heavy rain events. Even during small rains, stormwater is delivered directly to the steep slope above the creek through a number of

[3] National Research Council (U.S.) et al., *Restoration of Aquatic Ecosystems Science, Technology, and Public Policy*.
[4] Ibid.

outfalls, causing erosion and sedimentation of the creek. As excessive stormwater erodes the creek, pollutants from the parking lot harm the creek's water quality.

1.3 Sligo Creek Watershed

The Sligo Creek subwatershed contains 11.1 square miles of urbanized land in Montgomery County, Maryland, and is home to 82,000 people.[5] Sligo Creek is a tributary to the Anacostia River, which flows into the Potomac River, which empties into the Chesapeake Bay. The Maryland Department of the Environment (MDE) added the Anacostia River to the state's Clean Water Act (CWA) section 303(d) list of impaired waters in 2002 for biological impairment, which included the Sligo Creek subwatershed. While restoration efforts in the Sligo Creek subwatershed have improved Sligo Creek's "fish Index of Biotic Integrity" from a "poor" to a "fair" rating, the Sligo Creek subwatershed is still contributing pollutants like phosphorus, nitrogen and sediment into the Anacostia River.[6] The local non-profit organization Friends of Sligo Creek (FOSC) identified the campus of Washington Adventist Hospital, as a contributor of excessive stormwater into

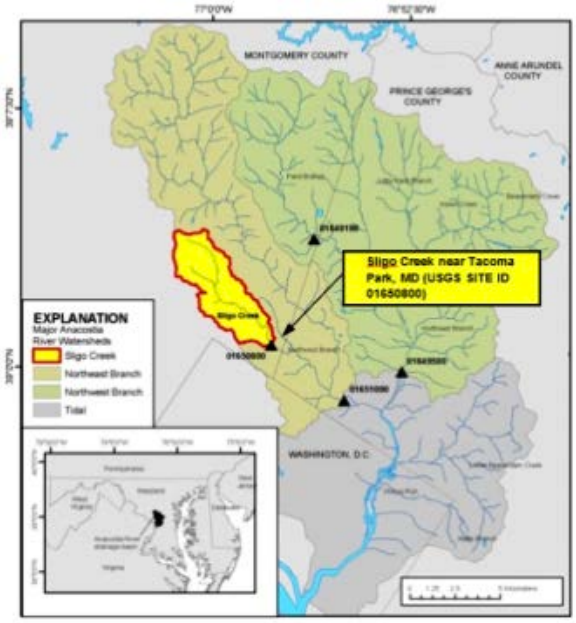


Figure 1.3 "Sligo Creek Watershed" by USGS

[5] US EPA, "Maryland."
[6] Ibid.

Sligo Creek, causing erosion and contributing to the creek's, and to the Anacostia River's sediment and pollution issues.[7]

Collaboration with FOSC began in June 2014 by reaching out to the President of FOSC, Kit Gage. During a walk along Sligo Creek, Kit revealed that the Adventist Hospital campus, situated above Sligo Creek, with a steep wooded slope down to the Creek, was contributing a great deal of stormwater to the Creek. According to Kit, during heavy rain events stormwater flowing off of the hospital's campus would blow out the hillside spreading mud, rocks and other debris, over the bike path which runs along the Creek, creating hazards for trail users, scouring out the creek, and loading the Creek with excess sediment. When asked whether developing a new campus design for Adventist Hospital that used stormwater Best Management Practices (BMPs) and other conservation landscaping techniques, would be useful for the health of the Creek and a useful tool for FSC to use, Kit responded enthusiastically in the affirmative.

1.4 Pollutant Loads from Parking Lots

Global studies estimate there are 600,000,000 passenger cars on the road and that number continues to grow.[8] In the US, it is estimated that 3,515 square miles are occupied by parking lot.[9] Parking lots predominately contain surface dusts of fine particles, which are too small for street sweepers to pick up. Therefore fine sediments are a big problem in parking lots. EPA found that pollutant levels were almost five times higher on a slow

[7] Gage and Sorvalis, Walking Sligo Creek.
[8] Revitt et al., "The Sources, Impact and Management of Car Park Runoff Pollution."
[9] Ibid.

one-way street compared to a busy, wider and faster moving road because of lower traffic speed and less frequent street sweeping.[10] A treatment train incorporating permeable paving and bioretention was recommended as the most effective way of maximizing pollution removal efficiency.[11]

1.5 Adventist Hospital Lacks Outdoor Healing Spaces

Being in a hospital for long hours can be stressful for not only patients and their family members, but also for hospital staff. While nature and fresh air used to be valued for relieving stress and healing from medieval times through the early 20th century, hospital design took on a more corporate and institutional form starting in the 1950s, replacing natural ventilation with air conditioning and creating indoor settings aimed at maximizing efficiency over patient well-being.[12] Today, more and more hospitals are reversing this trend by incorporating, among other things, healing gardens into the landscape to once again utilize the therapeutic effects that nature has on us. However at Adventist Hospital,

Figure 1.4 "Hospital View from Sligo Creek." By Author

[10] Ibid.
[11] Ibid.
[12] Marcus, "Healing Gardens in Hospitals."

there remains a lack of outdoor healing spaces and a need to provide some, in order to help relieve the stress that a hospital setting can have on patients, families, and hospital staff.

1.6 Good Timing to Offer a New Design

In December 2015, the Maryland Health Care Commission ruled in favor of Washington Adventist Hospital's application to move many of its services to a new campus it will build north of White Oak, MD. Since this recent decision, interest groups are beginning to come together to imagine a new vision for the existing Takoma Park campus. The timing could not be better to offer the design in this thesis as an option that would improve Adventist Hospital's landscape performance in regards to public well-being and creek health.

1.7 Developing the Thesis Question

Knowing that: 1: the Sligo Creek Watershed, as part of the Anacostia Watershed, is listed by the MDE as "impaired;" 2: Adventist Hospital's campus and parking lot contribute erosive quantities of untreated stormwater into Sligo Creek; 3: Parking lots contribute greater amounts of pollution to receiving waters than higher speed roads; 4: There is a local desire to clean up Sligo Creek; 5: Adventist Hospital lacks outdoor healing spaces; and 6: the Adventist Hospital community would benefit from the therapeutic effects of outdoor healing spaces, the following thesis question was formed: "What Best Management Practice stormwater mitigation techniques for Adventist Hospital Campus,

would better mitigate stormwater runoff into Sligo Creek, while providing outdoor healing spaces for the hospital community."

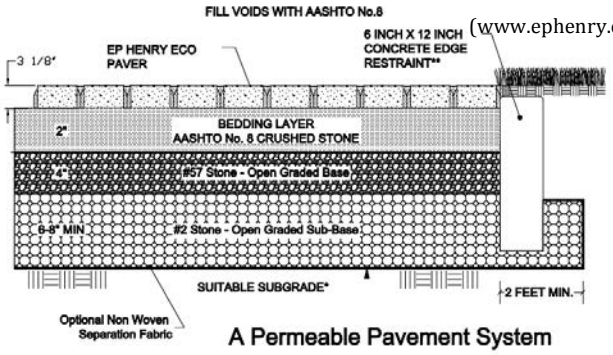
CHAPTER 2: LITERATURE REVIEWS AND RESEARCH

2.1 A Review of Best Management Practices to Mitigate Stormwater Impacts

Best Management Practices (BMPs) capture stormwater onsite and retain it until it filters into the soil, or release it over time to decrease peak flows that add to flooding and erosion problems.[13]

2.1.1 Permeable Paving

A study from 2013 examined the water quality performance of three permeable pavement systems, compared to a conventional asphalt pavement in Ontario. The article found that runoff from porous asphalt reduced loading of suspended sediments by 59%, Pb by 84%, Cd by 77% and Zn by 73%.[14] These studies concluded that significant improvements to stormwater quality can be achieved through the use of permeable pavements even without exfiltration to native soils because improvements to water quality are achieved by filtration through the permeable surface



(www.ephenry.com)

Figure 2.1 "Permeable Pavement Detail" by EP Henry

[13] "Storm Water Technology Fact Sheet, On-Site Underground Retention/Detention."
[14] Drake, Bradford, and Van Seters, "Stormwater Quality of Spring–summer-Fall Effluent from Three Partial-Infiltration Permeable Pavement Systems and Conventional Asphalt Pavement."

and aggregate layers. The effluent in these studies contained 80% less total suspended solids than the asphalt runoff and contained fewer heavy metals, as the permeable pavement system captured 65% to 93% of Cu. Fe, Mn and Zn.[15]

2.1.2 Bioretention Cells

Bioretention cells are increasingly being constructed as a means to collect, infiltrate and treat stormwater runoff.[16] Bioretention cells are shallow vegetated depressions in which the native soil has been removed and replaced with a bioretention media comprised primarily of sand and compost or mulch. The sand is used to promote infiltration while the organic rich compost or mulch is used to enhance plant growth. An investigation of six bioretention cells suggests that bioretention cells can provide more than six years of effective infiltration and over 25 years of effective metal removal performance.[17] The organic matter added to bioretention cells bonds with the positively charged metal contaminants found in stormwater runoff, removing them from the water before it is

(VIRGINIA DEQ STORMWATER DESIGN SPECIFICATION No. 9)

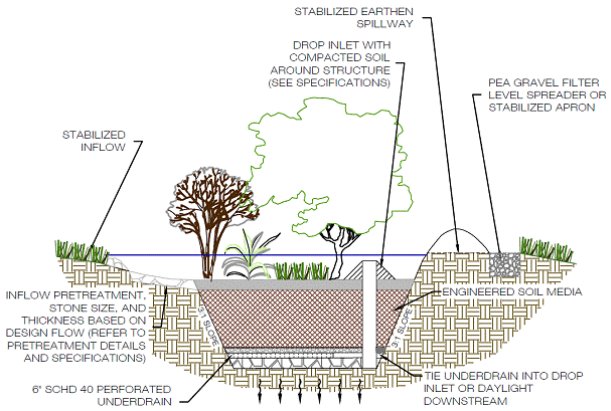


Figure 2.2 "Bioretention Cell Detail" by VA DEQ

[15] Ibid.
[16] Paus et al., "Assessment of the Hydraulic and Toxic Metal Removal Capacities of Bioretention Cells After 2 to 8 Years of Service."
[17] Ibid.

infiltrated or released back into the surrounding environment. Organic matter also absorbs petroleum hydrocarbons, removing automobile pollution in stormwater.[18]

Field studies of bioretention cells typically report good to excellent pollution removal (64% to >90%) for many metals including cadmium (Cd), lead (Pb), and zinc (Zn), many of the same pollutants found in paring lots (Davis et al. 2003; Glass and Bissouma 2005; LI and Davis 2008a).[19]

Figure 2.3 "Underground Stormwater Treatment" by Jensen Stormwater

2.1.3 Underground Storage

A 2001 EPA fact sheet asserts that underground storage of excess stormwater is advantageous where space is limited or valuable, however also identifies the disadvantage that underground storage only addresses water quantity issues, not water quality issues. Underground storage vaults can be constructed in a variety of materials, including high-density polyethylene (HPDE), aluminum/steel, corrugated metal pipe (CMP), or concrete, each with its own set of costs and advantages and disadvantages. EPA stressed that if underground storage is an approach undertaken, it should be included as part of a treatment train, so water quality improvements are also realized. In fact, some jurisdictions require water quality improvements as part of stormwater management.[20]

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[18] Ibid.
[19] Ibid.
[20] "Storm Water Technology Fact Sheet, On-Site Underground Retention/Detention."

2.1.4 Underground Treatment

A field monitoring program was implemented for 2 years at Albarmarle County Office Building parking lot in Charlottesville, VA, to assess the effectiveness of the Stormvault underground storage and treatment system, at improving water quality. The study monitored total suspended solids (TSS), chemical oxygen demand (COD), total phosphorus (TP), and orthophosphate (OP). The parking lot studied is almost 100% impervious with a drainage area of one-third acre.

Typically with underground vault-type BMPs, such as the Stormvault system, four types of solids removal technologies are widely used; namely: gravity separation, swirl concentration, screening, and filtration.[21] Stormvault was developed by a partnership with Colorado State University, Write Water Engineers Inc., and other professionals to meet the requirements of the National Pollution Discharge Elimination System Phase II. Stormvault is designed to provide both stormwater quantity and quality improvements through gravity settling and retention features, and can be equipped with hydrocarbon mats to absorb some organic floatables. Trapped sediment is removed by vac-truck and disposed of according to applicable regulations. After gathering data on these pollutants from 35 storm events over a 2 year period, results showed the following removal efficiencies: TSS 82.46%, COD 73.10%, TP 47.37%, and OP 52.54%.[22]

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[21] Ru Zhang et al., "Field Evaluation of an Innovative Stormwater Treatment Device—the Stormvault System."
[22] Ibid.

2.1.5 Grassed Swales

Studies were carried out in Northern Sweden during 2000-2002 to determine how well grassed swales function for stormwater pollution control during rain and snowmelt with regards to the retention of suspended solids, particles and heavy metals.[23] Grass species were Kentucky blue grass and Red Fescue grass. The study did not demonstrate any relationship between suspended solid removal and swale design for the swales with dense turfs. One swale study observed the swale as a pollution source rather than a pollution trap, when the water entering the swale was below a certain pollution concentration. For suspended solids, no significant removal occurred when the influent concentrations were below 40 mg/l. But when SS concentrations were above 100mg/l, removal efficiencies of more than 50% were generally observed.[24] Grassed swales should be used as part of a treatment train that delivers the water to another treatment mechanism. One advantage of swale over pipe is that they are convenient snow deposit areas. Pollution trapping increased exponentially with swale length, suggesting a majority of pollutants are captured in the first few meters of the swale. Higher removal efficiencies (75%) were observed.[25] Grasses swales even out pollution loads without being capable of producing consistent high pollution removal rates, and should be used as primary treatment devices among a treatment train of stormwater treatment mechanisms.[26]

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[23] Bäckström, "Grassed Swales for Stormwater Pollution Control during Rain and Snowmelt."
[24] Ibid.
[25] Ibid.
[26] Ibid.

2.2 Healing Gardens and Theory

Healing gardens are green spaces at hospitals and healthcare facilities that promote relief from symptoms, relief from stress, and improvement in overall sense of well being and hopefulness based on the theory that humans are hard-wired to find nature engrossing and soothing.[27]

2.2.1 Attention Restoration Theory

Attention Restoration Theory, developed by Stephen and Rachel Kaplan, tells us that pain requires considerable conscious attention.[28] Therefore when patients become distracted or engrossed in a pleasant nature view, their pain will diminish because they have less directed attention to their pain. The theory goes on to predict that the more engrossing the distraction, the more the pain will be reduced. Therefore nature views with other engrossing elements, like running water or wind chimes, will have a greater impact on reducing pain in patients.[29]

Attention Restoration Theory also predicts that time spent in, or looking at nature can alleviate "directed attention fatigue," resulting from the limits of the human brain to focus indefinitely on a specific task or stimulus.[30] The Kaplans assert that the four following experiential elements must be present in a natural setting to provide restorative effect that combats directed attention fatigue: 1 – Extent (feeling immersed in nature); 2 – Being

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[27] "What Are Healing Gardens?"
[28] Marcus and Sachs, *Therapeutic Landscapes*.
[29] Ulrich et al., "A Review of the Research Literature on Evidence-Based Healthcare Design."
[30] Environment et al., "Attention Restoration Theory."

away (not necessarily distant, but somewhere else); Fascination (having your attention captured effortlessly); and 4 – Compatibility (feeling connected to the natural environment).[31]

2.2.2 Biophilia Theory

Biophila theory holds that humans' positive response to nature is based partially on genetics, and it is innate in humans – part of human nature.[32] In his 1984 book, American biologist Edward O. Wilson defines biophilia as "the urge to affiliate with other forms of life."[33] Biophilia touches on many values including: Utilitarian (the physical benefits humans obtain from nature such as protection, sustenance, protection and security); Naturalistic (eliciting such emotions as fascination, wonder, and awe at the natural world); Ecologistic/Scientific (interconnectedness and energy transfer among organisms, mostly at the microbial and invertebrate level); Aesthetic (Nature is beautiful); Symbolic (humans use nature, symbolically, to communicate and nature is linked to the development of human language); Humanistic (strong affection, deep emotional attachments, love for nature); Therapeutic (experiences follow this intense state of being that nature evokes; Moralistic (an ethical and even spiritual responsibility to protect nature); Dominionistic (exploitative human practices towards nature); and even Negativistic (fear of the natural world).[34]

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[31] Ibid.
[32] Marcus and Sachs, *Therapeutic Landscapes*.
[33] Wilson, *Biophilia*.
[34] Ibid.

2.2.3 Prospect/Refuge Theory

Prospect/refuge theory is based on a notion that early human hunter-gatherers responded positively to landscapes that included elements conducive to their survival, like shelter, safety, food, water, light; while intuitively avoiding environments that threatened their survival.[35] The ideal landscape according to this theory would be perched on a vantage point, while not being able to be seen – a safe and concealed place which provides a view of the landscape, like a concealed perch overlooking a savannah.

These theories are supported by the following case studies that produce empirical evidence of nature sounds and settings providing for greater restorative effects in people than urban settings.

2.2.4 Effective Healing Gardens Motivate Patients

Mary Jane Lovering describes the work of her firm, Veretechs Design, Inc., that focuses on designing institution landscapes for physically and mentally challenged individuals. Through research, they discovered elderly are sensitive to glare, "lose color discernment," and problems with depth perception, among the more obvious issues with the physically demanding aspects of

Figure 2.4 "Holy Cross Hospital Healing Garden" By Oculus

[35] Marcus and Sachs, *Therapeutic Landscapes*.

aging.[36] Based on a study conducted on 10 homes for the aged, the research concluded that the primary determinant for outdoor space use was motivation, second was being able to use the space independently, and third was comfort.[37] This article sited Roger Ulrich's landmark 1984 study showing even views of natural landscapes from inside the hospital contributed to positive outcomes for patients.[38] Based on creating landscapes for over 160 facilities for different user groups, Lovering's firm concluded that "A therapeutic landscape will endure if, and only if, every detail is configured to motivate patients and visitors to experience the outdoors, and do so as independently and comfortably as possible."[39]

Physical Elements of a Healing Garden 2.2.5

The landscape architect Virginia Burt focuses on healing gardens in a healthcare setting, and the gardens' potential to be transformative. She sites the works of Paul Deveraux "Revisioning the Earth" and Edmund O'Sullivan. Liminal space is talked about in reference to the state of being of the patient or their loved one's *being in between*, with a confusing present and an uncertain future.[40] Healing gardens are intended to address this dynamic. The article references the Schneider Healing Garden at Seidman Cancer Center to describe the different aspects of a healing garden. Healing gardens should be designed for not only patients, but also family members, caregivers, volunteers, staff,

[36] Lovering, "Texture, Colour, Sound + Fragrance."
[37] Ibid.
[38] Ulrich, "View through a Window May Influence Recovery from Surgery."
[39] Lovering, "Texture, Colour, Sound + Fragrance."
[40] Burt, "'It's Somewhere Else Instead' Healing Gardens as Transformative Spaces."

donors and management.[41] The four physical aspects often encountered in healing gardens include: Gateway, Boundary, Center and Path. The goal of the garden is "transformative learning." Here are some elements described: 4 cardinal directions; labyrinth; seven colors of the chakras; air, earth, wind and fire; Initiation, Illumination, Integration.[42]

2.2.6 Experiential Elements of a Healing Garden

Stephen S.Y. Lau and Feng Yang studied healing garden's benefits to students under pressure from a stressful academic environment.[43] The article invokes the Kaplan's "directed attention fatigue" theory and identifies natural settings as having restorative effects on people suffering from this condition that results from working intensively for long hours.[44] The four requirements for a restorative environment, according to Kaplan's theory are: 1 – Being away (not necessarily distant); 2 – Fascination (effortlessly enjoying leaves in a breeze or flowing water); 3 – Extent (a sense of distance, even in limited areas); and 4 – Compatibility (resonance between people and nature while recreating in nature). Lau and Yang's article also cites Hartig's 2003 research that measured ambulatory blood pressure of 112 adults linking natural surroundings to aiding the physical and psychological restoration of urban dwellers, and Ulrich's 1984 study that demonstrated swifter post-operation recovery from patients that had a window view of a

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[41] Ibid.
[42] Ibid.
[43] Lau and Feng Yang, "Introducing Healing Gardens into a Compact University Campus."
[44] Ibid.

natural setting, vs. those patients viewing a brick window.[45] Ulrich's 1999 literature suggests healing gardens in a healthcare setting offer the following resources: sense of control and access to privacy; social support; physical movement and exercise; and access to nature and other positive distractions.[46]

2.2.7 Nature Has A Measurable Positive Effect On Us

The 1984 study by Roger S. Ulrich published in "Science" followed 46 patients who had underdone cholecystectomoy, a common type of gall bladder surgery, and compared the recovery process for patients who had a view of a wall, to patients who had a view of a natural setting with trees. The study concluded that the patients with the tree view had shorter postoperative hospital stays, fewer negative evaluative comments from nurses, took fewer moderate and strong analgesic doses, and had slightly lower scores for minor postsurgical complications.[47] This study is significant because it demonstrated to the medical community that the physical environment had a measurable positive effect on patient health, and improved health outcomes.[48]

Ulrich et al. subsequently conducted a literature review of more than 400 peer reviewed articles and found "especially strong evidence" indicating links between access to nature and health outcomes, including links between access to nature and reduced depression,

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[45] Ibid.
[46] Ibid.
[47] Ulrich, "View through a Window May Influence Recovery from Surgery."
[48] Marcus and Sachs, *Therapeutic Landscapes*.

reduced length of hospital stays, increased patient satisfaction, decreased staff stress, and increased staff satisfaction.[49]

2.2.8 A Walk in the Woods Reduces Stress

In 2008, researchers in Japan measured university students' physiological stress levels after the students walked in a forest environment, and compared those results with the same group of students walking in a city environment.[50] A total of 280 students responses were measured in 24 forests across Japan. The stress indicators researches measured included salivary cortisol (a stress-indicator hormone), blood pressure, pulse rate, and heart rate variability. Researchers found that forest environments promote lower concentrations of cortisol, lower blood pressure, lower pulse rate, greater parasympathetic nerve activity, and lower sympathetic nerve activity that do city environments.[51]

While a forest setting lowers stress compared to an urban setting, several studies have found that if incongruent urban sounds, like street traffic, are heard even while in a natural setting like a forest, or a healing garden, those urban sounds tend to have a negative effect on restorative healing.[52] When siting a healing garden, nature sounds

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[49] Ibid.
[50] Park et al., "The Physiological Effects of Shinrin-Yoku (taking in the Forest Atmosphere or Forest Bathing)."
[51] Ibid.
[52] Marcus and Sachs, *Therapeutic Landscapes*.

should be maximized and urban sounds like air conditioners, street traffic… should be minimized or masked by design interventions such running water.[53]

2.3 Migratory Bird Habitat

Migratory birds travel thousands of miles across flyways that span vast distances, yet anthropogenic habitat fragmentation and pollution are degrading the natural habitats along the migration routes that migratory birds depend upon for rest and nourishment.[54] To help highlight the importance of international cooperation to protect migratory birds and their habitats, the organization Environment for the Americas created International Migratory Bird Day, which takes place annually around May 14.[55] Many of the 350 migratory birds species that have nesting habitats in North America use the Sligo Creek Valley.[56]

In an effort to both raise awareness of migratory birds, the threats they face and how Sligo Creek Valley provides them with critical habitat, educational placards describing the migratory birds and their habitat, is proposed to be installed on the site. In addition, information on migratory birds can elicit the therapeutic and restorative responses in visitors associated with transformative learning. As we learned from Virginia Burt, patients or loved ones of patients visiting the healing garden are often in a liminal state, a state of being in between a confusing past and an uncertain future. The concept of

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[53] Ibid.
[54] unep, "Loss and Degradation of Natural Habitats Threaten Migratory Birds, Pushing Species towards Extinction - UNEP."
[55] "Environment for the Americas."
[56] Olivar et al., "Spring Migrant Bird Sightings."

transformative learning can address this state and provided a transcendent and therapeutic experience for visitor.

In order to incorporate migratory bird habitat, research was undertaken to identify migratory birds that have been seen and are know to breed in the Sligo Creek Valley (listed on the left column of figure 2.3.1). Once these birds were identified, their habitat and food needs were researched. With this information, a planting typology for the site was developed specifically aimed at enhancing the habitat value for the birds identified.

2.3.1 Migratory Bird Habitat & Food Preferences

Migratory Bird[57]	**Habitat Preferences**[58]	**Suitable Plants**[59]
Black-crowned Night Heron	Marsh; Nests in trees or cattails.	Woody vegetation; trees or shrubs.
Yellow-crowned Night-Heron	In and near wetlands. Nest near or over water.	Mulberry, myrtle, hackberry and mangrove.
Chimney Swift	Nest in dim, enclosed areas.	Urban and suburban forests, rivers, lakes and fields.
Ruby-throated hummingbird	Live in open woodlands, forest edges, meadows, grasslands, parks, gardens and backyards.	Tubular flowers
Eastern Wood-Pewee	Clearings and forest edges; any type of wooded habitat.	Trees and shrubs. Feed on insects. Also eats seeds of dogwood, blueberry, raspberry, and poison Ivy.
Acadian Flycatcher	Mature forests, deciduous, along streams, in ravines and swamps.	Slings hammock-like next over fork in tree, usually over water.
Eastern Phoebe	Uses buildings and bridges	Eat flying insects; nest also

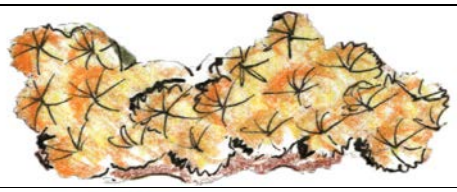
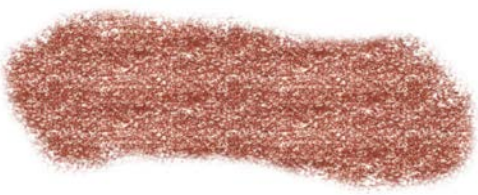
[57] Ibid.
[58] The Cornell Lab or Ornithology, "All About Birds."
[59] Ibid.

	for nests.	on woods edges.
Great Crested Flycatcher	Make use of nest boxes. Live on the edges between habitats.	Eats plants that fruit berries; prefers open broadleaf tree habitat.
Eastern Kingbird	Prefers meadow habitats.	Fruiting plants.
White-eyed Vireo	Shrubby areas	shrubs
Warbling Vireo	Deciduous habitats, but also uses some mixed conifers.	Deciduous and coniferous trees.
Red-eyed Vireo	Deciduous forests	Eat caterpillars from deciduous trees
Barn Swallow	Like open areas. Feed on beetles, bees, wasps, ants, butterflies, moths and other flying insects.	Nest on human made structures.
House Wren	Backyards, city parks, grassy fields, forest edges.	Shrubs and low tree branches, grass
Blue-gray Gnatcather	Deciduous forests near edges	Steal food from spider webs
Veery	Forage on ground of rich deciduous forests	Prey on invertebrates
Wood Thrush	Deciduous and mixed forest w/ large trees, understory, shade and leaf litter.	Eat invertebrates from forest floor.
Gray catbird	Dense tangles of shrubs, small trees, vines, streamside thickets	Shrubs and small trees
Brown Thasher	Dense regenerating woods,	Tangles masses of shrubbery
Cedar Waxwing	Gardens, woodlands of all kinds.	Fruiting trees or shrubs
American Redstart	Open woodlands dominated by deciduous trees	Eats insects
Ovenbird	Most forest types from oaks, to maples to dry pine forest. They avoid swampy areas.	Forages on the ground
Kentucky Warbler	Deciduous forests	Nests on the ground
Common Yellowthroat	Open areas with thick, low vegetation.	Migrations they used a variety of habitats including backyards and forest.
Scarlet Tanager	Like undisturbed tracks of forest.	
Eastern Towhee	Brushes, tangles and thickets	Forage on forest floor. Leaf litter.
Chipping Sparrow	Open woodlands, forests	Feed on the ground and take

	with grassy clearings, long roadsides, backyard.	cover in shrubs. Like evergreens to perch on.
Field Sparrow	Like areas of tall grass and brush near small trees and shrubs.	Roses and briers
Indigo Bunting	Weedy fields and shrubby areas	Where field meets forest. They love edges.
Red-winged Blackbird	Marshes, along watercourses, drier meadows and fields.	They eat grains. Virginia wild rye…
Brown-headed Cowbird	Fields, pastures, meadows, forest edges, lawns.	They feed on ground with Starlings. Also perch high on prominent tree branches while not feeding.
Baltimore Oriole	Leafy deciduous forest, open woodlands, forest edge, stands of trees along rivers, parks and backyards.	Feed high in trees searching for insects, flowers, and fruit

Figure 2.5 "Migratory Bird Habitat and Food Preferences" By Author

Migratory Bird Food and Habitat Typologies

Birds	**Group**	**Habitat or Food Preferences**	**Visual Depiction of Habitat Preferences**
Red-Winged Blackbird	1	Grainy grasses	
Veery, Ovenbird, Kentucky Warbler, Eastern Towhee, Chipping Sparrow, Brown-headed Cowbird	2	Feed or nest on rich forest ground	

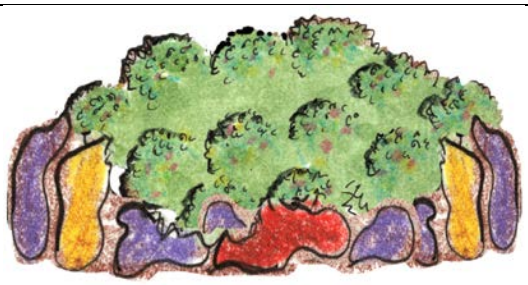
Ruby-throated hummingbird, Eastern Wood-Pewee, Great Crested Flycatcher, Eastern Kingbird, White-eyed Vireo, Gray Catbird, Brown Thrasher, Cedar Waxing, Common Yellow throat, Field Sparrow, Indigo Bunting	3	Feed on tubular flowers, fruiting shrubs, berries, dogwoods. Like tangles of thickets.	
Chimney Swift, Acadian Flycatcher, Eastern Phoebe, Warbling Vireo, Red-eyed Virio, House Wren, Blue-gray Gnatcatcher, American Redstart, Baltimore Oriole	4	Deciduous Forests, Wooded Forest Edges	
Black-crowned Night Heron Yellow-crowned Night Heron	5	Mulberry, Myrtle, Hackberry, Woody Vegetation	

Figure 2.6 "Migratory Bird Food and Habitat Typologies" By Author

CHAPTER 3: SITE INVENTORY AND ANALYSIS

3.1 Methods/Analysis Overview

First a stormwater analysis was completed on the entire campus. Following the stormwater analysis, a healing garden suitability analysis was completed to identify a site that would be well suited for a healing garden. Then once a potential healing garden site was identified, a soils analysis, building walls and views analysis, circulation analysis, and site-specific stormwater analysis was completed.

3.2 Campus-Wide Stormwater Analysis

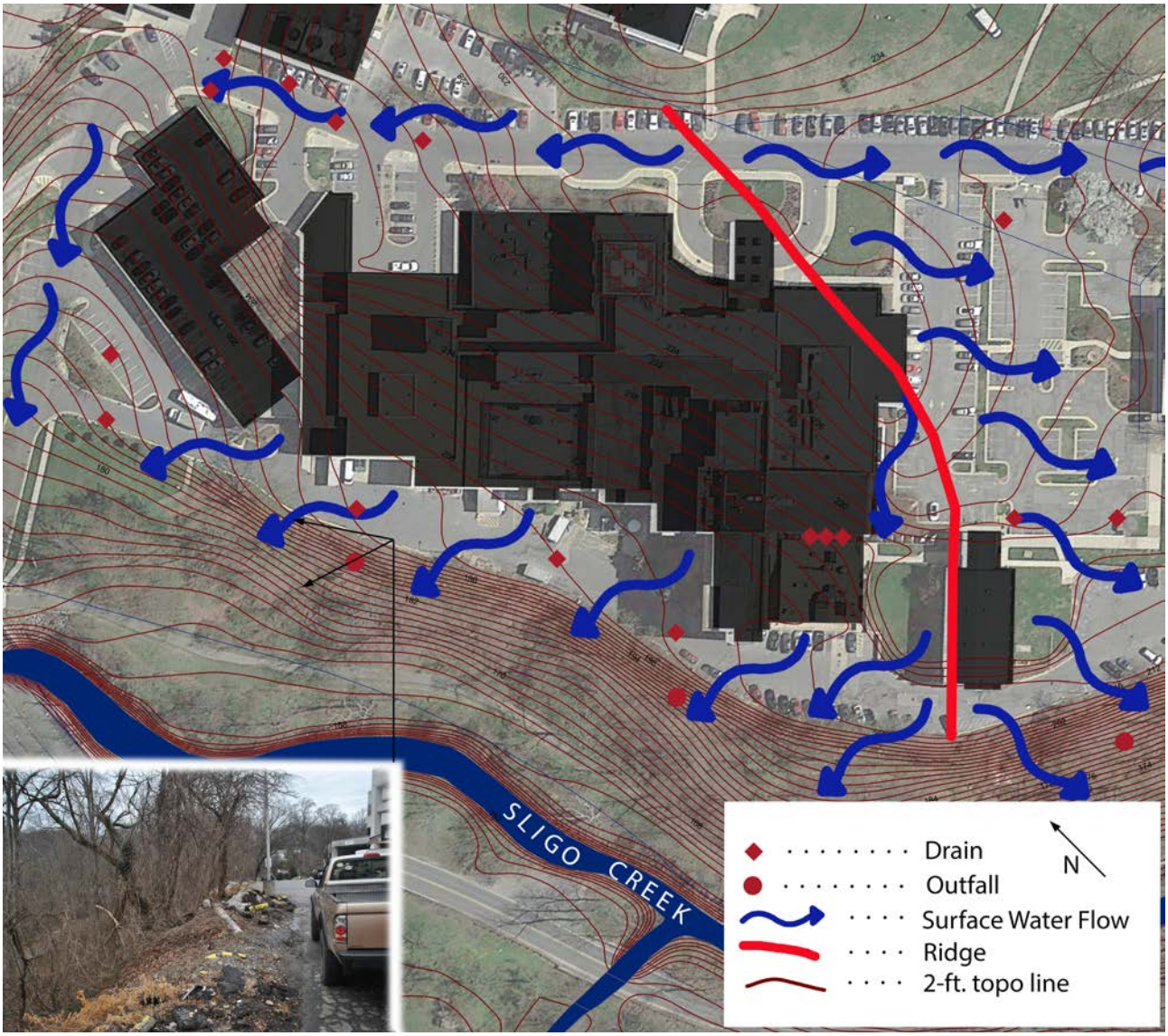


Figure 3.1 "Campus-Wide Stormwater Analysis" By Author

inlets, which outlet on the SW slope above Sligo Creek. Stormwater that is not collected in the drains, especially on the SW forest-facing side of main building, sheet flows directly into the woods above Sligo Creek. None of the stormwater is treated before flowing into the drain inlets, or directly into the forest, delivering water containing parking lot pollution, directly onto the steep slope just above Sligo Creek.

3.3 Healing Garden Suitability Analysis

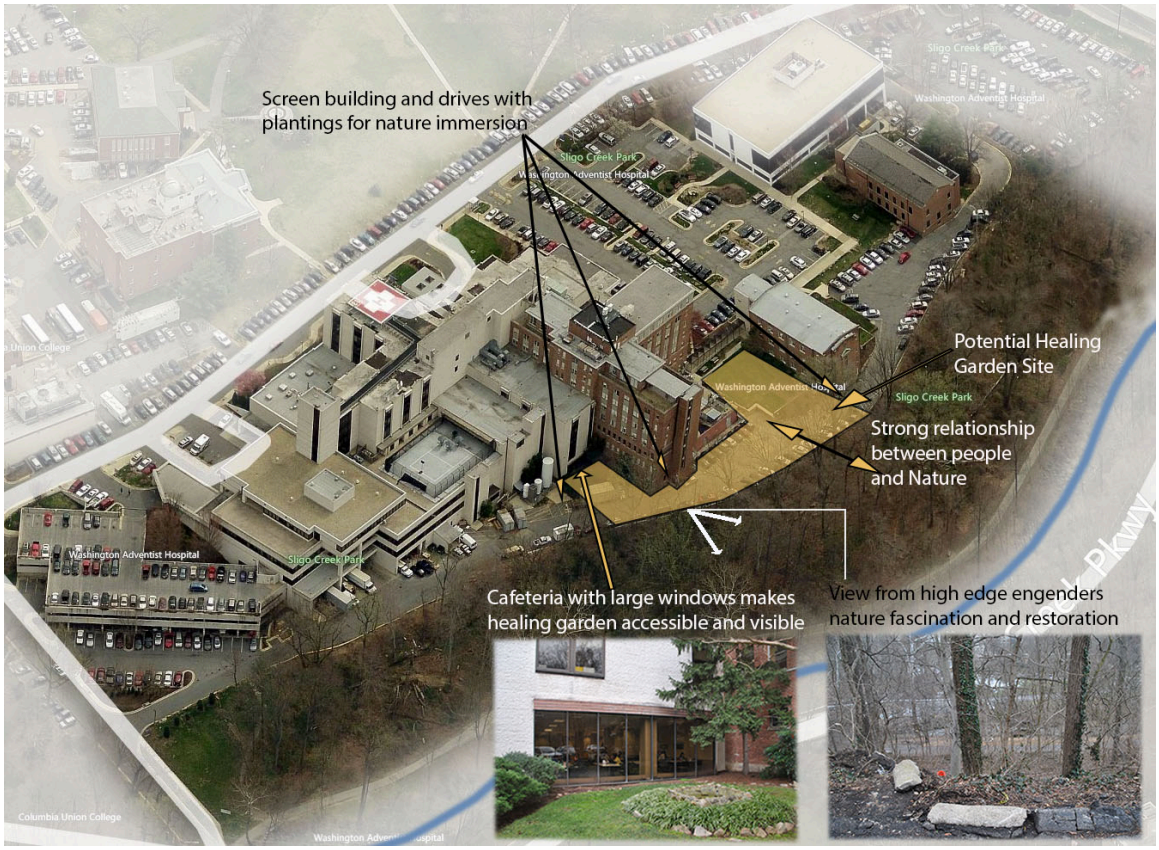


Figure 3.2 "Healing Garden Suitability Analysis" By Author

As Virginia Burt stated that healing gardens will only be used if they "motivate patients and visitors to experience the outdoors, and do so as independently and comfortably as

possible,"[60] the choice was made to site the healing garden directly adjacent to the cafeteria, making it convenient to patients, staff and loved ones to access the site, as they congregate to eat and are able to view the healing garden from outside the large bay cafeteria windows.

In addition, the SE forest-facing side of the building where the cafeteria is located also provides the strongest connection to nature, being located on a relatively flat ridge above a natural wooded slope, which leads down to Sligo Creek. By installing foundation plantings against the buildings and enclosing the views across the paved/automobile areas with evergreens, a visitor in the site can experience a nature immersion.

According to Biophila theory and the Kaplan's restoration theory, this nature emersion will produce therapeutic and restorative responses in visitors. In addition, with the site abutting a natural wooded slope with nature expressing herself through wind blowing leaves, hawks circling above, an expansive view into a creek valley, the Kaplans' experiential elements of being away, fascination, compatibility and extent will be easy to provide with minimal design interventions.

3.4 Circulation Analysis

This circulation analysis analyzes the area around the proposed intervention site, which is located at the backside, or rear of the hospital, facing the creek, where the

[60] Burt, "'It's Somewhere Else Instead' Healing Gardens as Transformative Spaces."

shipping/receiving and some staff parking occurs. One can drive uninterrupted through this area as part of a route to circumference the hospital.

The pedestrian circulation that seems to go under the building in the diagram, is a very narrow walkway between building walls, partially covered by overhead structure and appears to only cater to staff that park at the back side of the hospital.

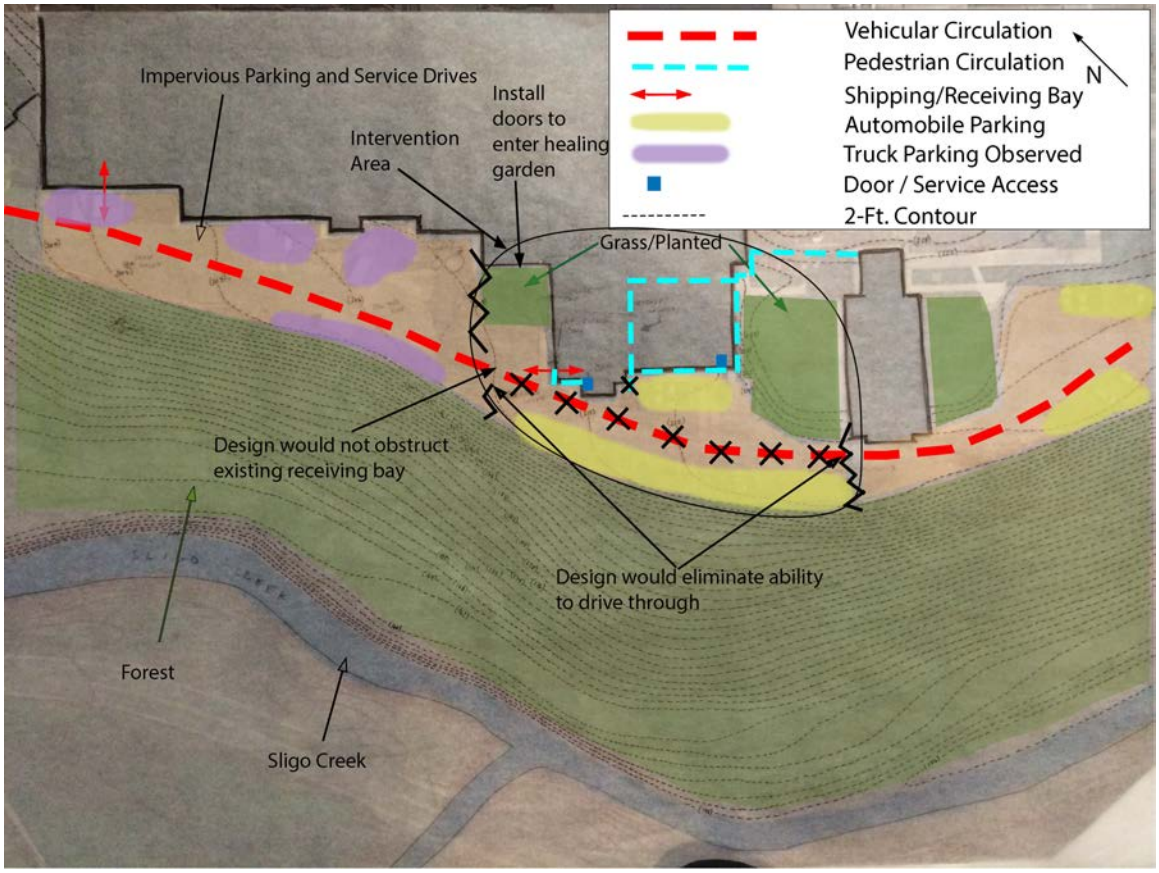


Figure 3.3 "Vehicular Circulation Changes" By Author

The proposed intervention would install planting across the drives, and include pedestrian circulation throughout the site, precluding vehicles from being able to circumnavigate the hospital.

3.5 Intervention Site Stormwater Analysis

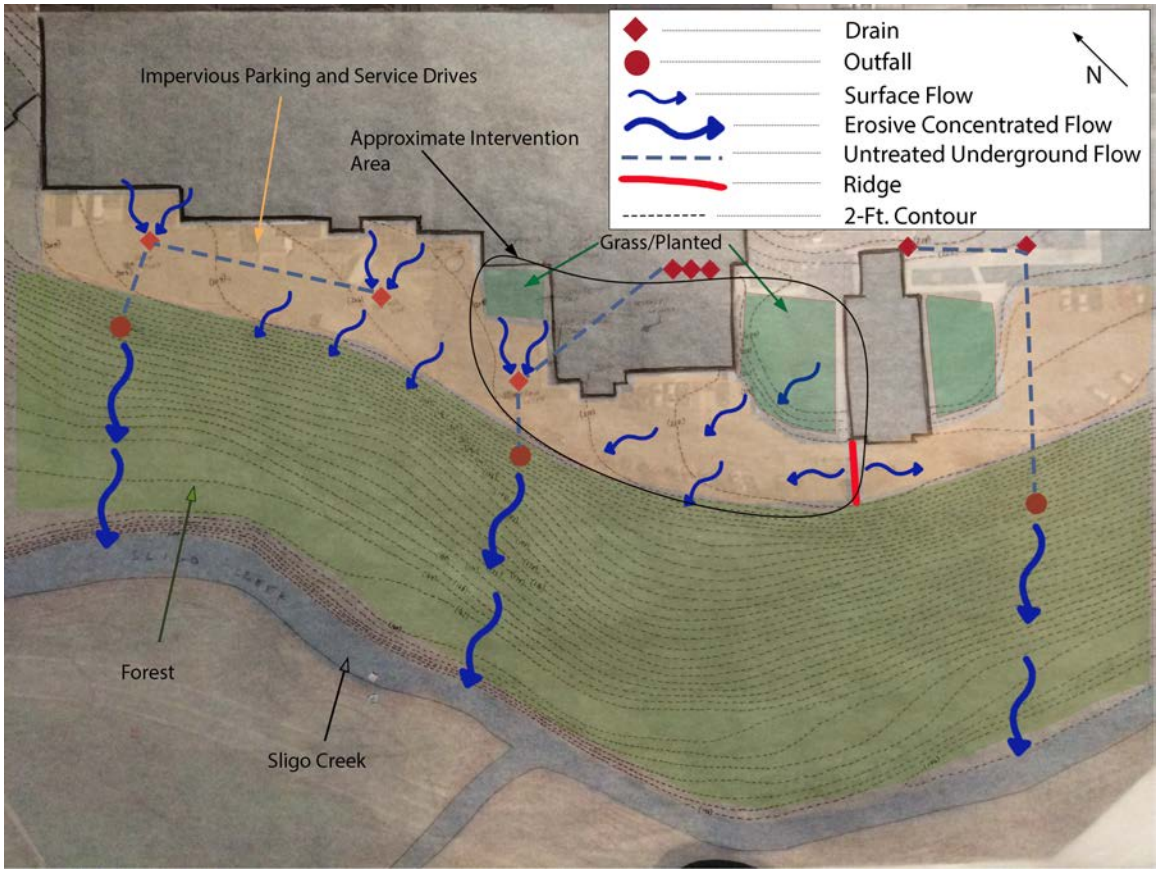


Figure 3.4 "Intervention Site Stormwater Analysis" By Author

The stormwater on the intervention area was either flowing into a drain and being released onto the forested slope through an outfall, untreated, or flowing directly off of the parking lot/service drive, onto the slope. By looking into the drains with a flashlight, the following Untreated Underground Flow network of pipes was deduced (see figure 3.4). Flowing out from each of the outfalls was untreated stormwater at concentrated amounts, forming erosive flows down the slope.

Of the intervention site's total area of 21,595 square feet (SF), 14,835 SF is impervious, not allowing for any infiltration, and 6,760 SF is pervious, allowing for some infiltration.

It was determined that in order to gain the most stormwater storage and treatment, all of the installed pedestrian pathways, including the service drive to the service bay, would be interlocking concrete permeable pavers. In addition, a bioretention area would also be installed to provide more stormwater storage and filtration, while also providing wildlife habitat.

3.6 Soils Analysis

A soils analysis was conducted by using the United States Department of Agriculture (USDA) Web Soil Survey (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm).

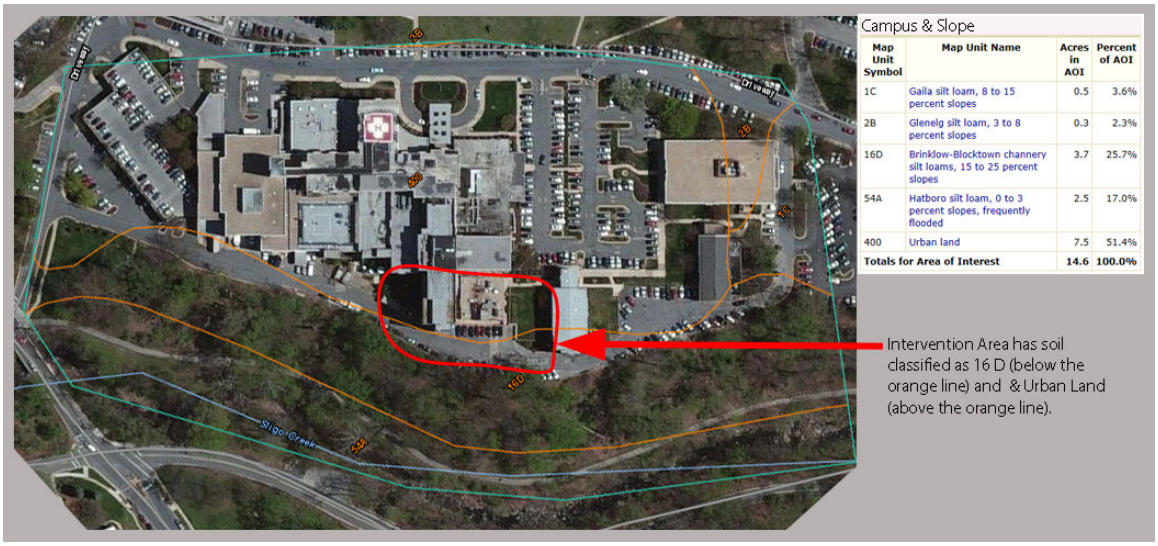


Figure 3.5 "Soil Analysis" By Author

Soils found on our intervention area include "D soils," and soils classified as "urban land." D soils have high runoff potential, low infiltration rates, and consist chiefly of clay

soils.[61] Since this soil profile includes predominately poorly drained soils and urban land, the proposed permeable paver system that includes a reservoir of stones with 40% void space to detain water, with an underdrain to carry off water that does not infiltrate, will help detain and filter water, that would otherwise runoff the poorly drained soils.

3.7 Building Views Analysis

There are many windows on the buildings surrounding the healing garden intervention site that offer views of the healing garden. The most important building view is view #1,

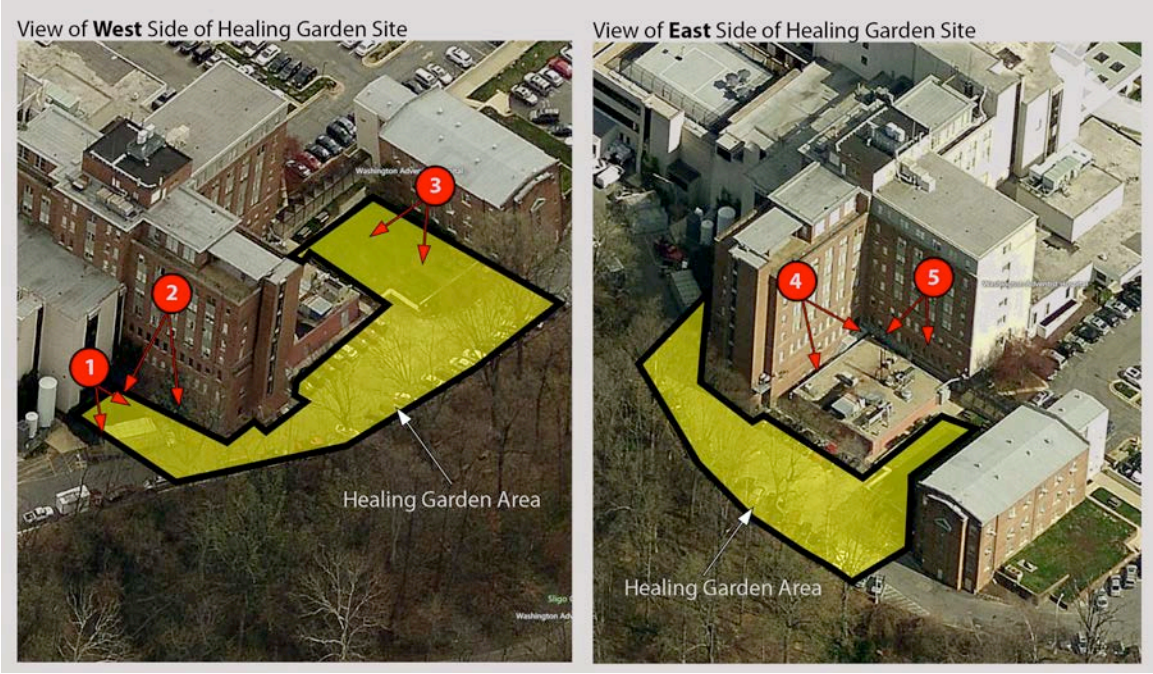


Figure 3.6 "Building Views Analysis" By Author

which as identified in Figure 3.2, is a ground-level cafeteria, with large bay windows looking out towards the forest. This view is important because it makes the healing garden very visible and accessible from a part of the hospital; namely the cafeteria, that draws patients, family member, hospital staff, and others from the hospital community.

[61] "appendixb3.pdf."

View #2, about mid-level on the building face, would also offer good views of part of the healing garden. View #3 would also offer good views from each of the three stories. Views #4 and #5 would be too distant from the healing garden to offer any detailed views, however the views will be enhanced when trees and healing garden features replace the asphalt and parking that currently occupies the site. The healing garden will add more nature to the views that hospital patients observe from views #1 to #5, creating a more healing and restorative environment for those patients with a view.

3.8 Demographics

Washington Adventist Hospital primarily serves residents of Montgomery County (40.3%), and Prince George's County (44.5%), in addition to Washington DC (6.4%) and elsewhere (8.8%).[62] The hospital's service area includes 1,253,641 people, or which 66.5% are minorities, and the median household income in the hospital's service are is $67,405.[63]

	2011 Estimates				
	WHITE	BLACK/AF AMER	ASIAN	NATIVE HI/PI	HISP/LAT
Total Service Area (TSA)	419,958	553,217	1,845	1,338	238,388
	33.5%	44.1%	0.1%	0.1%	19.0%

Figure 3.7 "Washington Adventist Hospital Demographics" by Washington Adventist Hospital

[62] "2013-CHNA-WAH.pdf."
[63] Ibid.

CHAPTER 4: DESIGN

With a thorough site inventory and analysis completed, a proposed site identified, and a series of goals to achieve, a set of functional diagrams were sketched to begin to uncover how different design approaches would respond to the existing conditions.

4.1 Results of Analysis

The site analysis and the functional diagrams were used to uncover the following design approaches:

- The cafeteria big bay windows offered the best visual access to the healing garden. Design intervention: Install a door at the windows location to grant access to the healing garden.
- A strong axis developed straight out from the proposed cafeteria door towards the slope edge. Design intervention: Install a deck on the axis to penetrate the forest and hang over the slope.
- Vehicular access must continue to be granted to the loading bay near the cafeteria windows.
- The centrally located area in the design will serve as the 'center' of the healing garden, being furthest from the vehicular and service activity. This center will be screened with evergreens and ample seating will be provided.
- An existing retaining wall that changes several feet in grade will be an opportunity to install a water feature that includes falling water for its fascination and sound buffering value.

- Since the site does not offer ample room for a large bioretention area, a small bioretention area could be installed and all pedestrian and wheelchair paths could be permeable interlocking concrete pavers to store and infiltrate rainwater falling on the site. The varying-sized stone media in the pavers will also filter toxins contained in the stormwater. The stormwater that does not infiltrate into the ground would be under drained into an existing stormwater inlet.

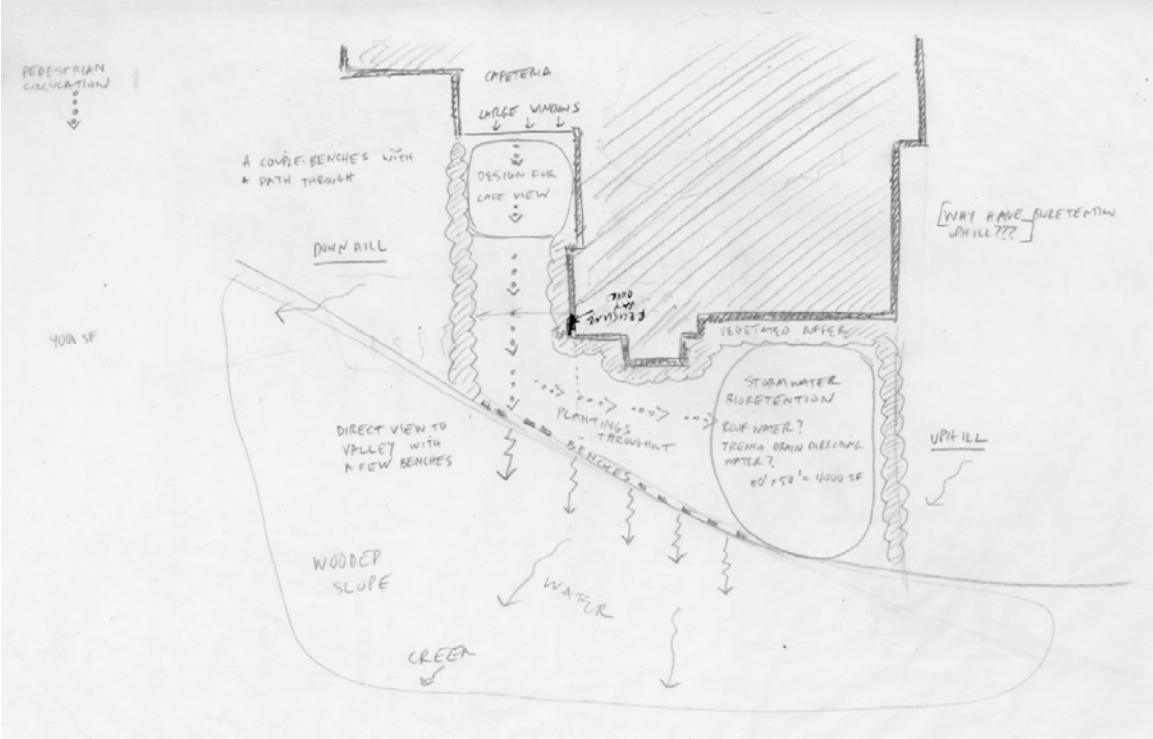


Figure 4.1 "Functional Diagram 1: Identifying Axis and Views" By Author

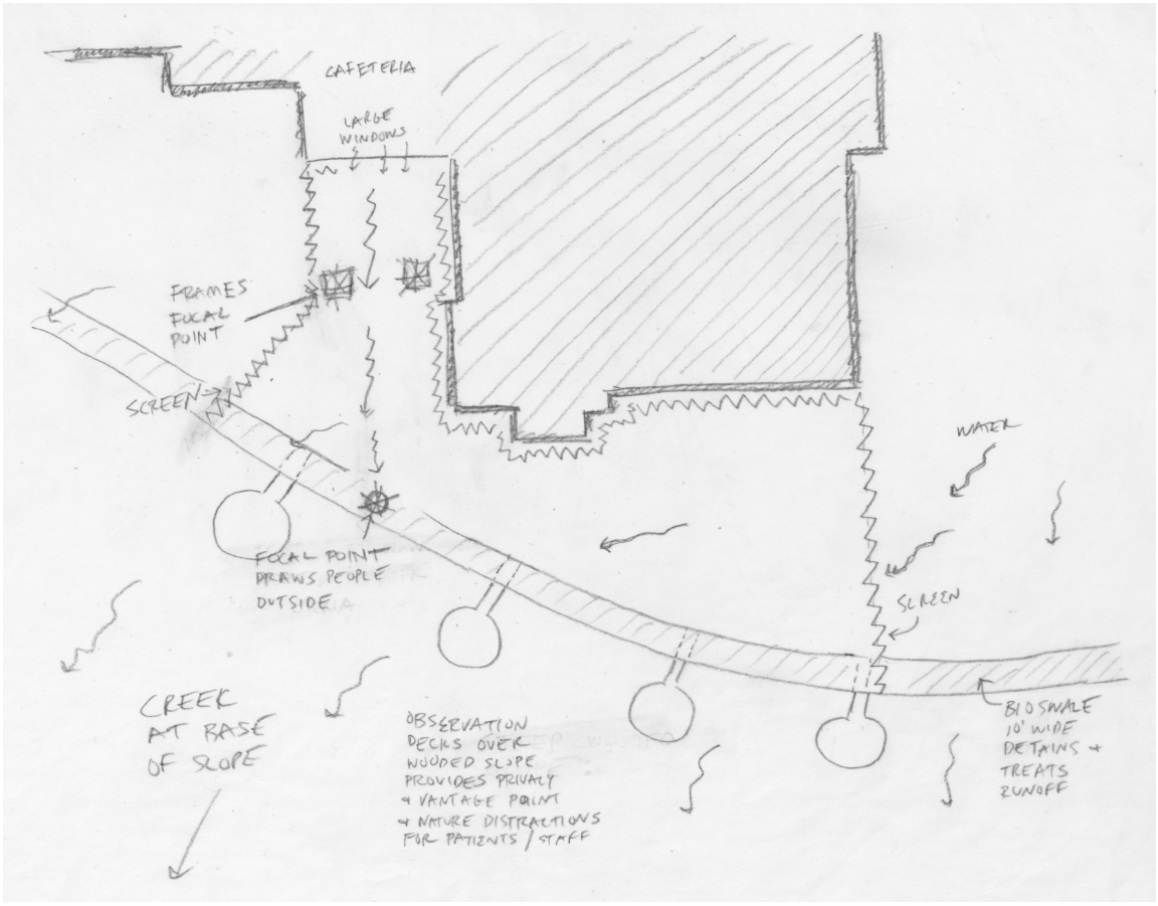


Figure 4.2 "Functional Diagram 2: Proposed Decks and Bioswale" By Author

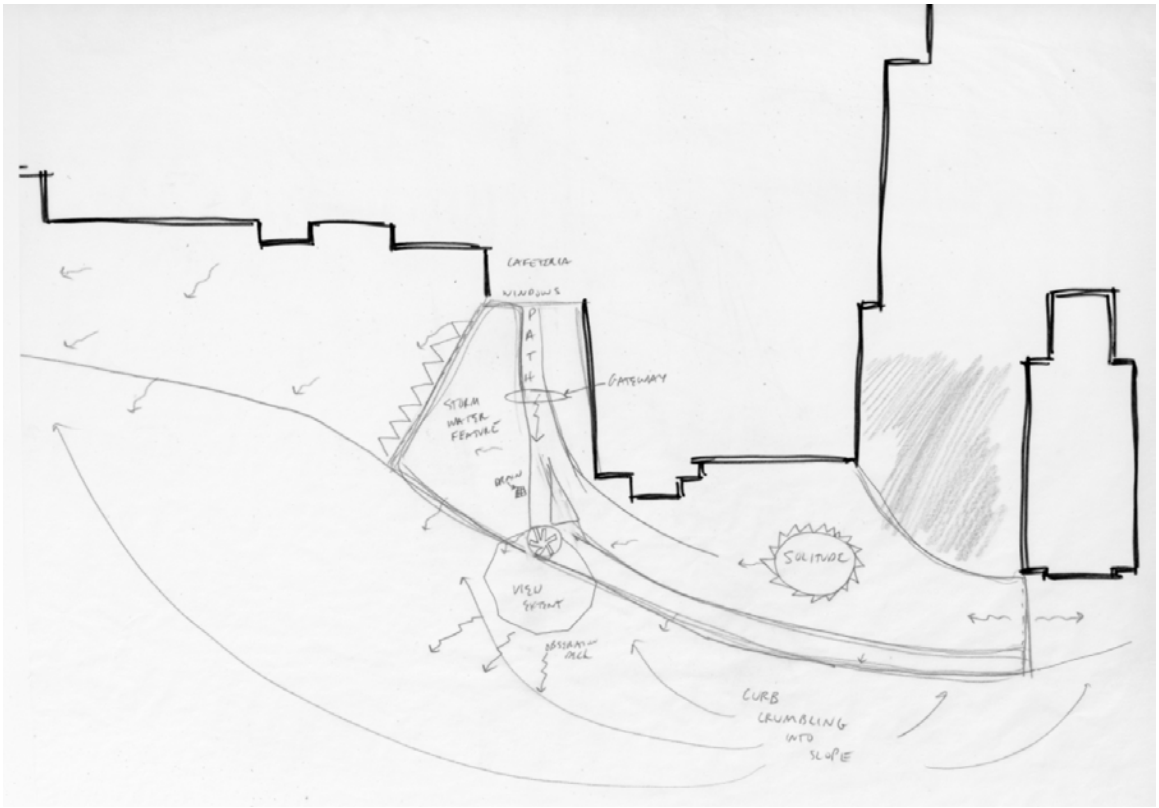


Figure 4.3 "Functional Diagram 3: Identifying Center & Expanding Area" By Author

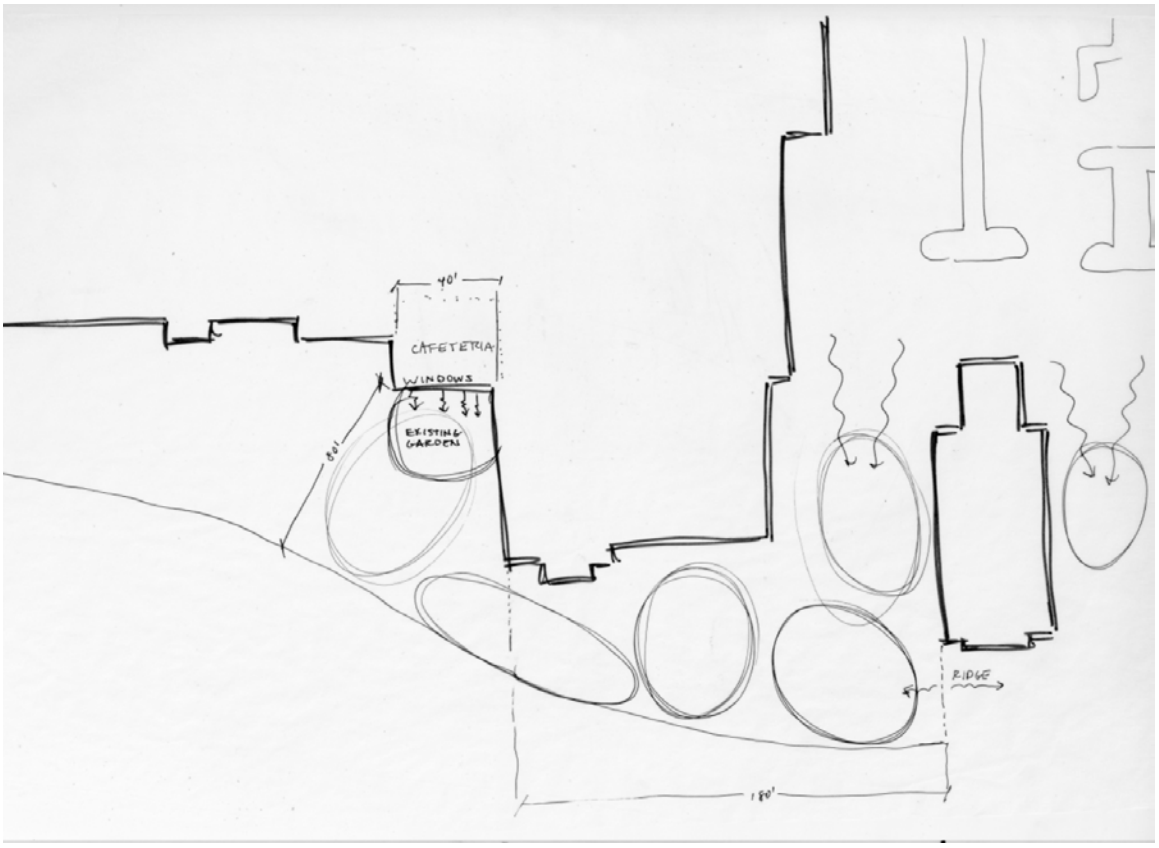


Figure 4.4 "Functional Diagram 4: Assessing Spaces & Dimensions" By Author

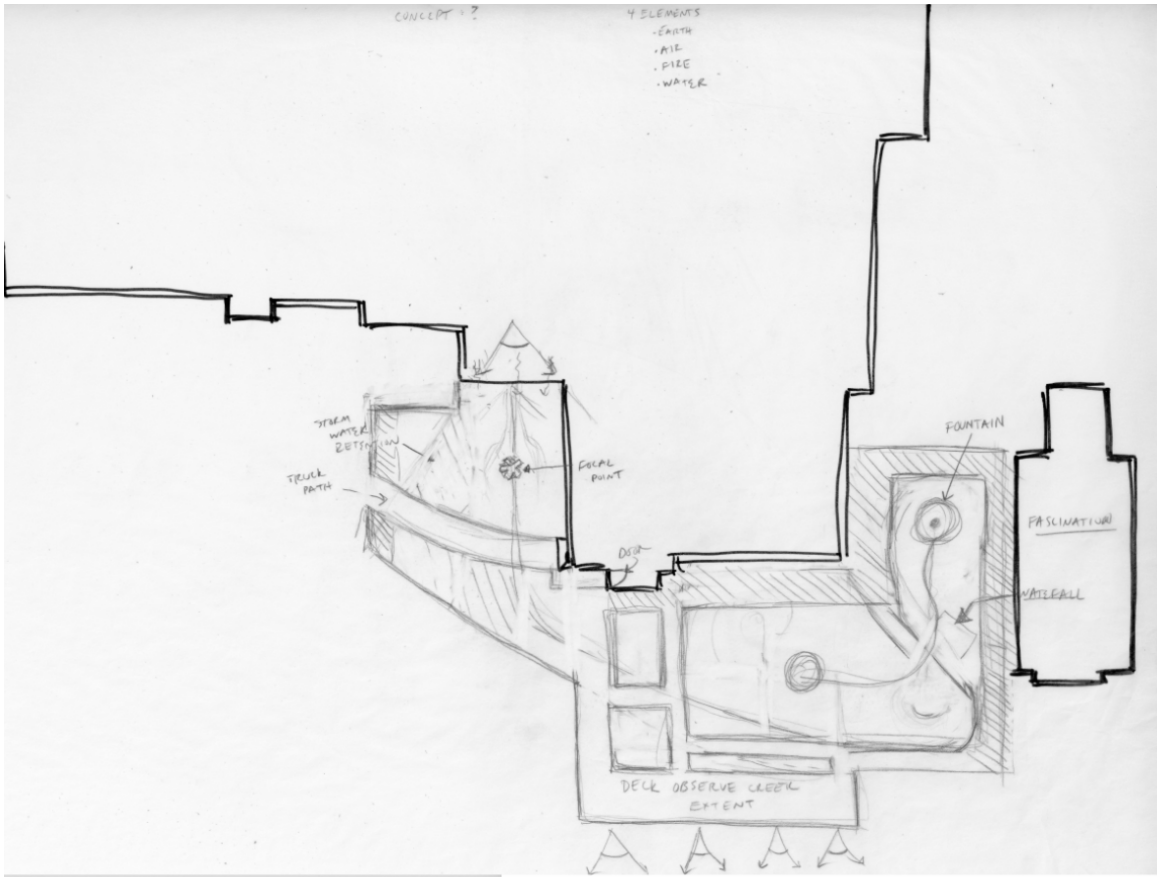


Figure 4.5 "Functional Diagram 5: Identifying Focal Point & Water Feature" by Author

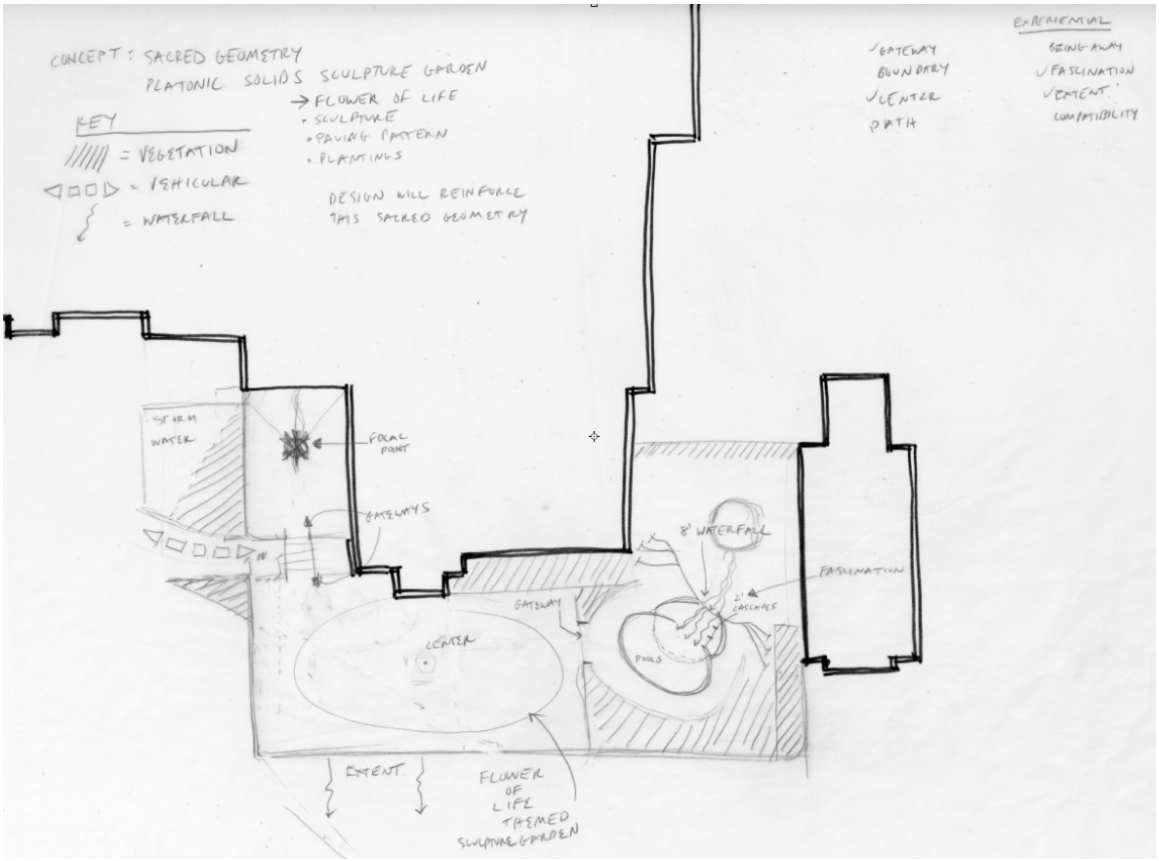


Figure 4.6 "Functional Diagram 6: Gateways Between Spaces" By Author

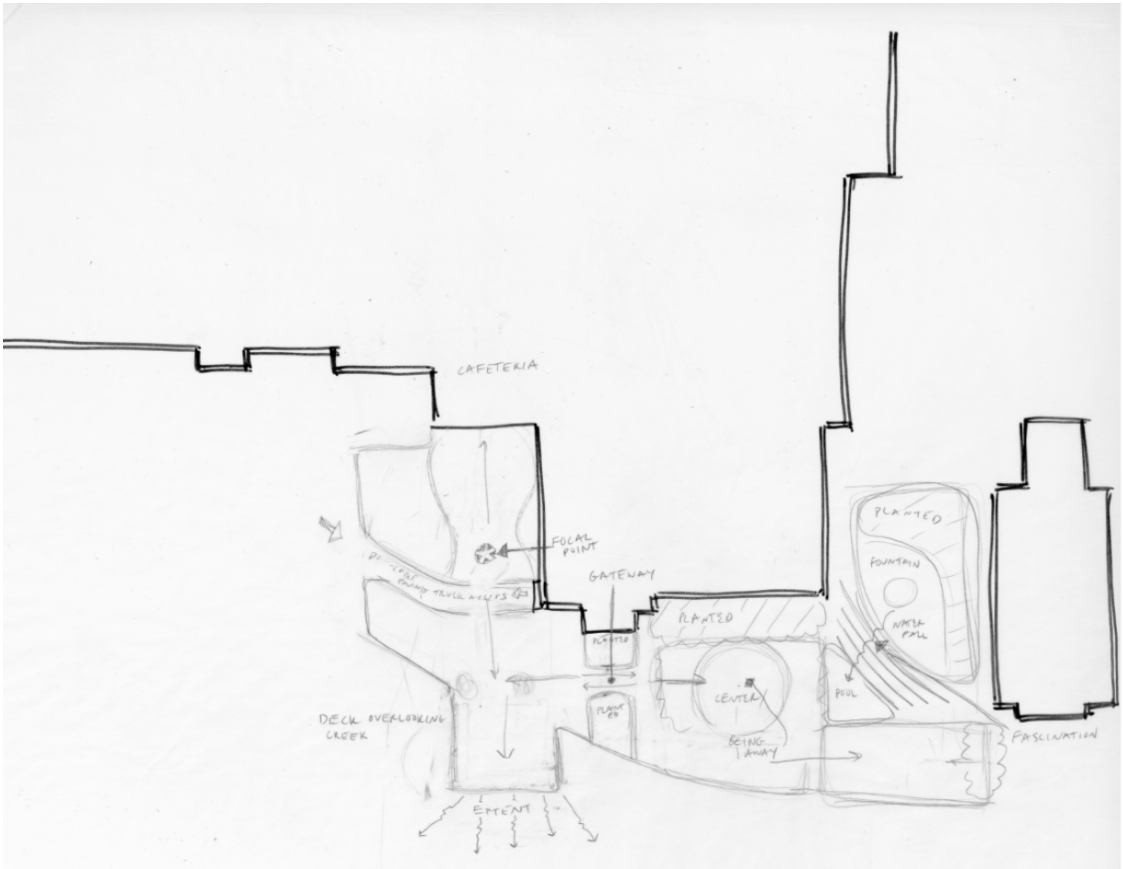


Figure 4.7 "Functional Diagram 7: "All Physical and Experiential Qualities Present" By Author

4.2 Concept Designs

The design took on the following form, and went through the following evolution through constructive feedback from thesis committee members.

4.2.1 Concept Design 1:

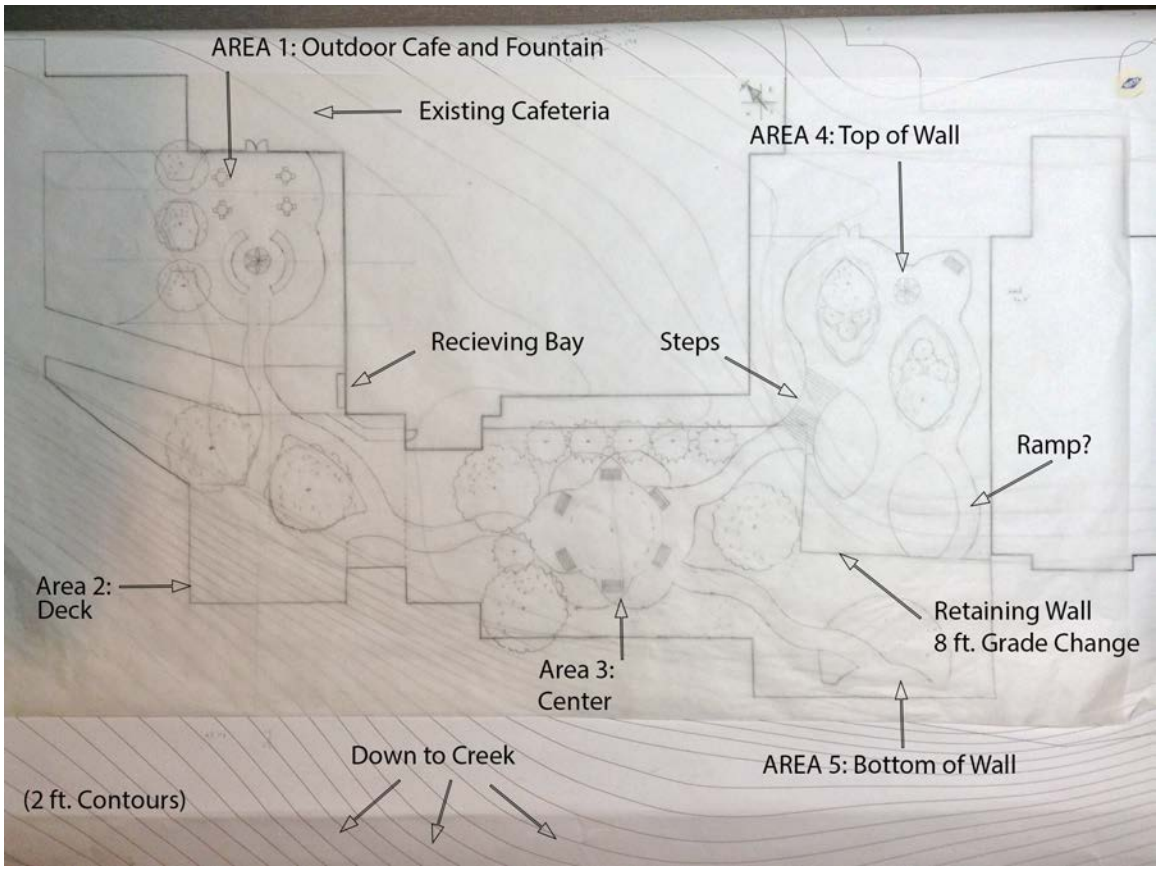


Figure 4.8 "Concept Design 1" by Author

This design incorporates the many elements of a healing garden. The physical elements are present; namely the Gateway, Boundary, Center, and Path. The Gateway is the entrance from the cafeteria in Area 1, and the Area 4 entrance. The boundary is depicted by the rectilinear edge that reflects the building geometry. The Center is Area 3 and the Path is curvilinear throughout the site. The experiential element of extent can be

experienced from the deck. However fascination, being away and compatibility are absent from this initial design.

4.2.2 Concept Design 2

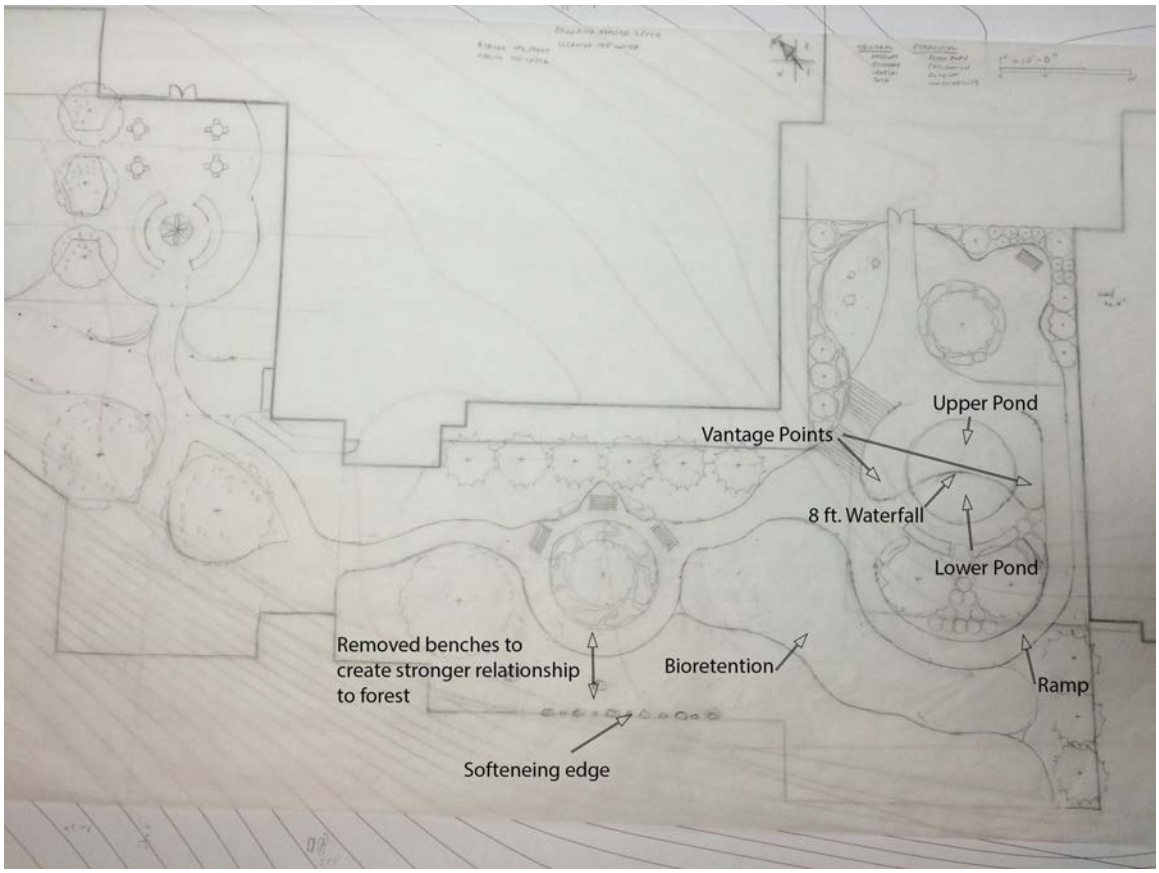


Figure 4.9 "Design Concept 2" by Author

Concept Design 2 sought to better integrate the receiving bay to the curvilinear paths. The design made Area 4 more of a transition/move-through area; better integrated Area 4 Top of Wall with Area 5 Bottom Wall by creating a waterfall that connects the two areas. The waterfall achieves the healing quality of Fascination. The area below the waterfall engenders the healing quality of Being Away. The design also added a bioretention area,

and removed benches facing away from the forest to create a stronger relationship between visitor and nature, better achieving the healing quality of Compatibility between people and nature.

4.2.3 Concept Design 3

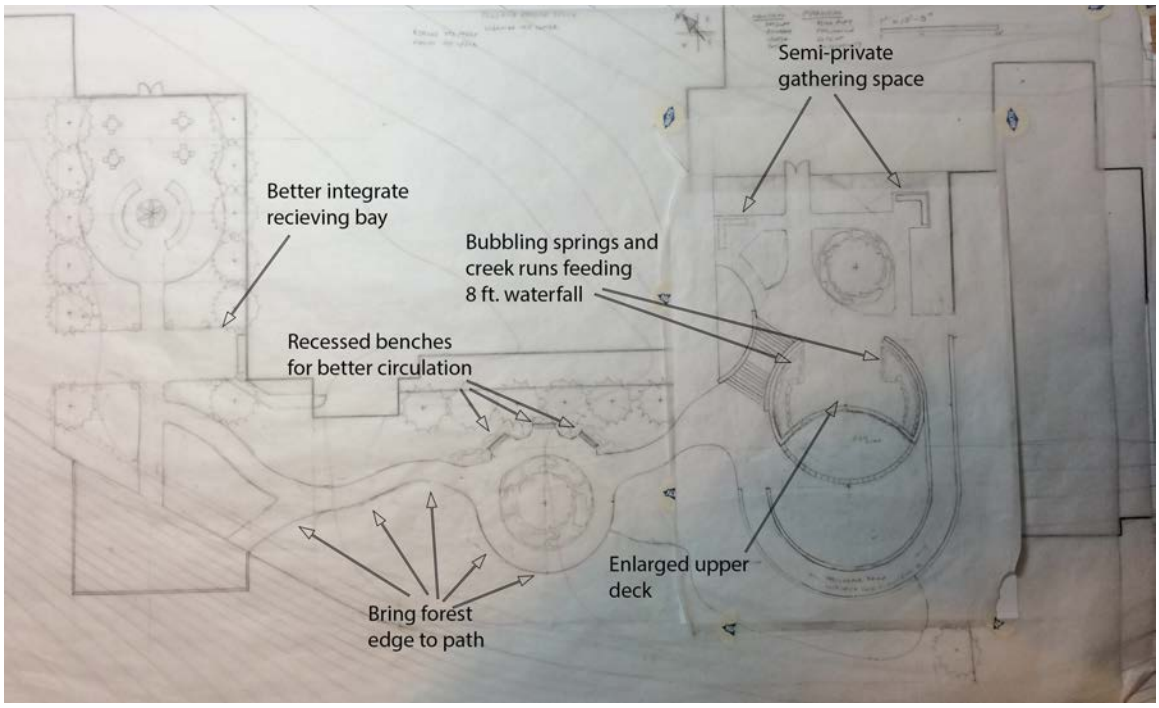


Figure 4.10 "Design Concept 3" By Author

Design Concept 3 modified Area 4's upper deck by enlarging it, and added 2 bubbling springs and creek runs that feed the waterfall. This adds to the healing element of Fascination. This concept also adds semi-private gathering space in Area 4, to enable families to use these added spaces to come together or consult as a group with a doctor. The hard forest edge that reflected the geometry of the buildings has given way and has become a naturalized edge.

4.3 Concept Design Sketches

Throughout the design process described above, the following series of sketching exercises were executed, to ensure the experiential qualities needed in a healing garden were present to the visitors in the spaces created, before the final design developed.

4.3.1 Seed of Life Fountain Area

Compatibility between people and nature is a fundamental experience that a visitor should experience in a healing garden. Nature's most important element it provides for us is water.

In order to draw people outside, and to immediately invoke the feeling of compatibility, an interactive fountain was designed and placed just outside the windows and on the axis that exists between the doors and the deck.

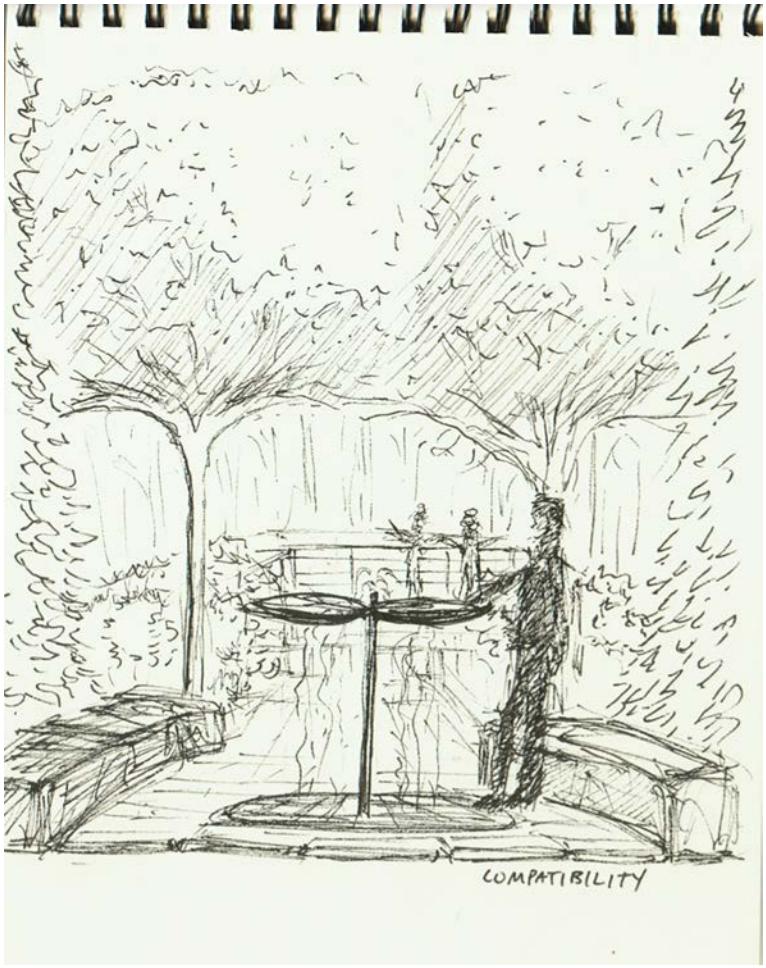


Figure 4.11 "Seed of Life Fountain Area Sketch" by Author

The Seed of Life Fountain sketch helped to test how it would feel in that space. Imagine you have just walked out of the cafeteria doors. This sketch illustrates the first experience you would have in the healing garden. The visitor would feel that compatibility with nature, and also be drawn down the axis

4.3.2 Deck and Migratory Bird Placards

Through sketching and imagining what it would be like to spend time on the deck, a number of functions the deck could provide emerged.

Figure 4.12 "Deck and Migratory Bird Placards Sketch" by Author

The feeling of extent, to perceive a distance, is an essential experiential quality in a healing garden. The view from a deck that is hanging off of a steep slope overlooking the Sligo Creek Valley is ideal to invoking the feeling of extent. In addition, the safe feeling one would have, based on prospect/refuge theory, is also a feeling the deck can invoke in

visitors, who have a high vantage point, and are protected at their backs by vegetation surrounding the deck.

The deck railing also offered an ideal area to place placards that could provide information on the migratory birds that use Sligo Creek Valley. The placards would be placed low, so children could also read them, and each could include a button that would trigger the sound of the corresponding bird call, and could include a QR code to be interactive with cell phones.

4.3.3 Center Bench Area

When considering the design for the Center Area (Area 3), it was important to make the visitor feel like they were at the 'center' of an area, ensuring that a center was included as part of the healing garden. This provided motivation to align the center bench with a centered tree, and to include plantings that provide a feeling of enclosure, to engender the feeling of 'being away.'

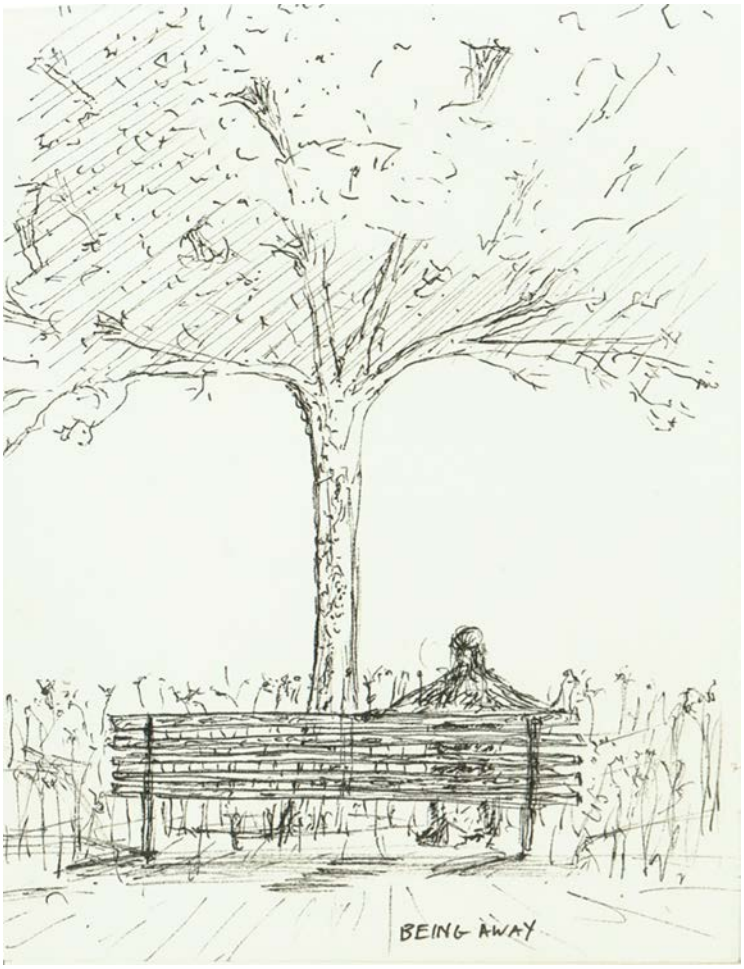


Figure 4.13 "Center Bench Area Sketch" by Author

To ensure that this strategy would invoke the intended feelings in the visitor, the following sketch was produced. If one imagines that dense plantings are included behind the bench, the visitor would feel like they were in a protected centered area away from the noise and hustle of the surrounding urban area.

4.3.4 Waterfalls Area

When imagining how it would feel in the lower pond area that is surrounded by the wheelchair ramp, and devoid of vegetating, a motivation occurred to green the space. Through a series of sketches, the waterfall, which was conceived originally as being a wall of water trickling straight down into a pond, transformed into planted slope, complete with shade trees and a series of cascading waterfalls.

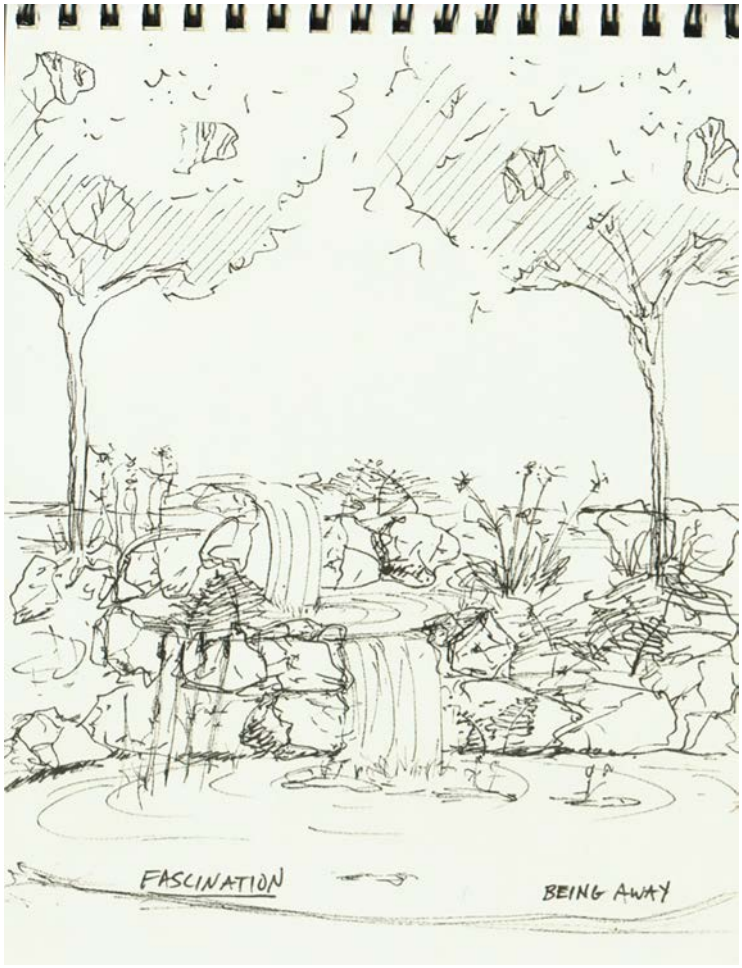


Figure 4.14 "Waterfalls Area Sketch" by Author

This sketch was the final in the series that was the motivating factor to change the design from a wall of water, to a planted slope with a series of waterfalls.

This modified design will do a much better job at invoking the feeling of fascination and of being away that are essential to a successful healing garden. In addition, the added vegetation will produce evapotranspiration, which combined with the shade of the added trees, will produce a much more comfortable microclimate, especially during the summer months.

4.3.5 Semi-private Gathering Spaces

One important design guideline in a healing garden is for it to provide semi-private spaces so patients have the opportunity to meet with doctors, or families can congregate as a group in a semi-private environment.[64]

Figure 4.15 "Semi-private Gathering Area Sketch" by Author

The Top of Wall (Area 4) provided a good opportunity to achieve semi-private seating. The following sketch helped the semi-private seating come sharper into focus. The seating areas in Area 4 would be surrounded by dense vegetation, and include benches that faced towards one another, providing both privacy and an easy way to sit to have conversation among a small group of people.

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[64] Marcus and Sachs, *Therapeutic Landscapes*.

CHAPTER 5: FINAL DESIGN

5.1 Illustrative and Labeled Plan

With the healing garden elements, stormwater mitigation techniques and migratory bird habitat typologies identified, what follows is a series of depictions of the final design.

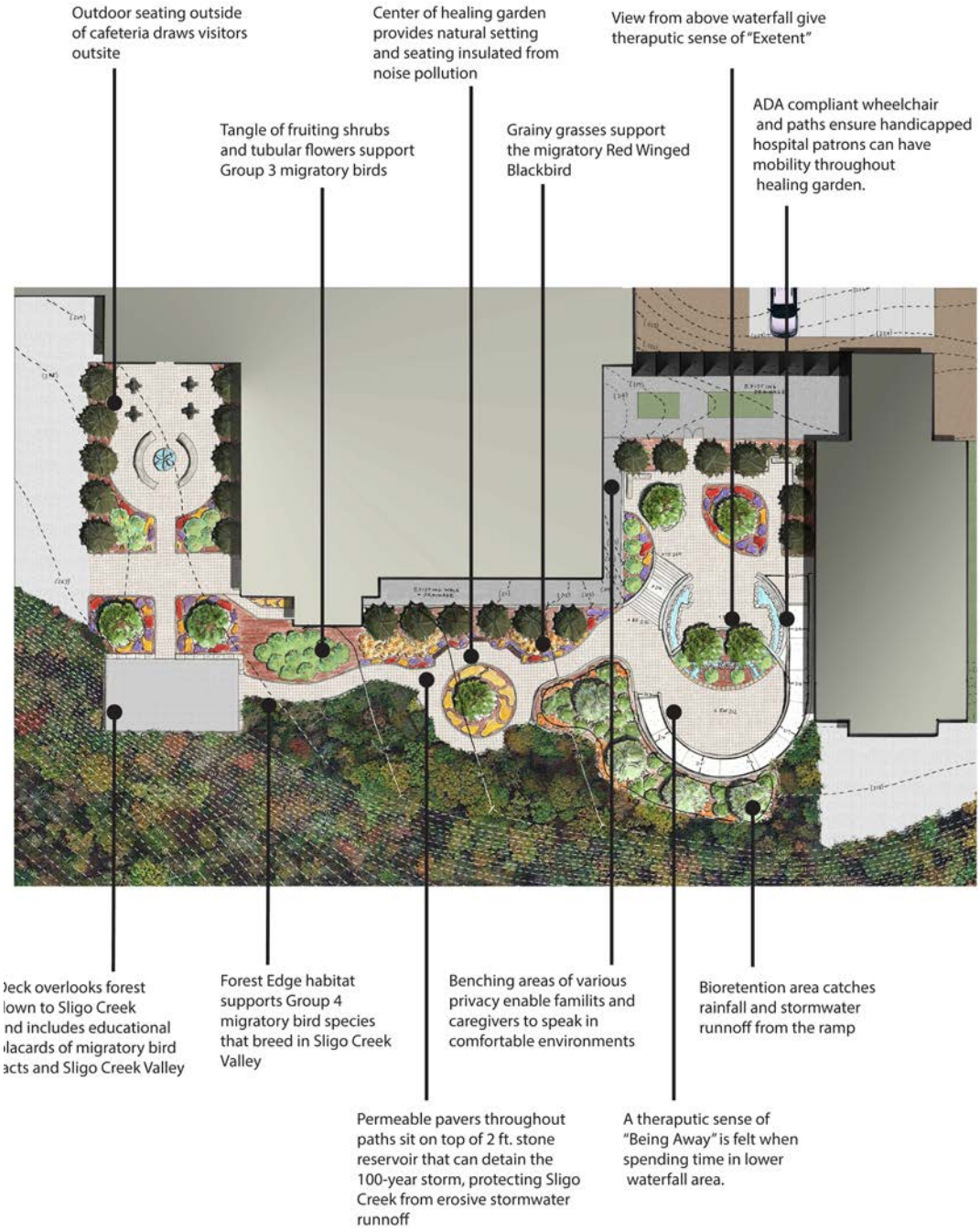

Figure 5.1 "Final Design" By Author

5.2 Illustrative Perspectives

While a stray from the academic approach taken by this thesis, the following section on Perspectives will be presented in a more poetic style. This change in style was pursued in order to more effectively illustrate the healing experiences a visitor navigating through the various healing garden spaces would feel.

5.2.1 Seed of Life Fountain Perspective

As you exit the cafeteria, the first area you get to is the Seed of Life Fountain and seating area. Here you see a child splashing in the water with a straight view to an overlooking deck that also captures your interest.

Figure 5.2 "Seed of Life Fountain Perspective" By Author

You have a seat near the fountain and are captivated by the water. We all depend on water. It is nurturing and you feel the compatibility between yourself and nature.

After being lost in thought, you notice a few people gathering on the deck and pointing to something in the forest. With your interest peaked, you walk down the path towards the deck to get a better look.

5.2.2 Deck Perspective

The ladies noticed an Oriole bird, Maryland's state bird. That is when you notice that mounted on the railings are placards of 31 birds.

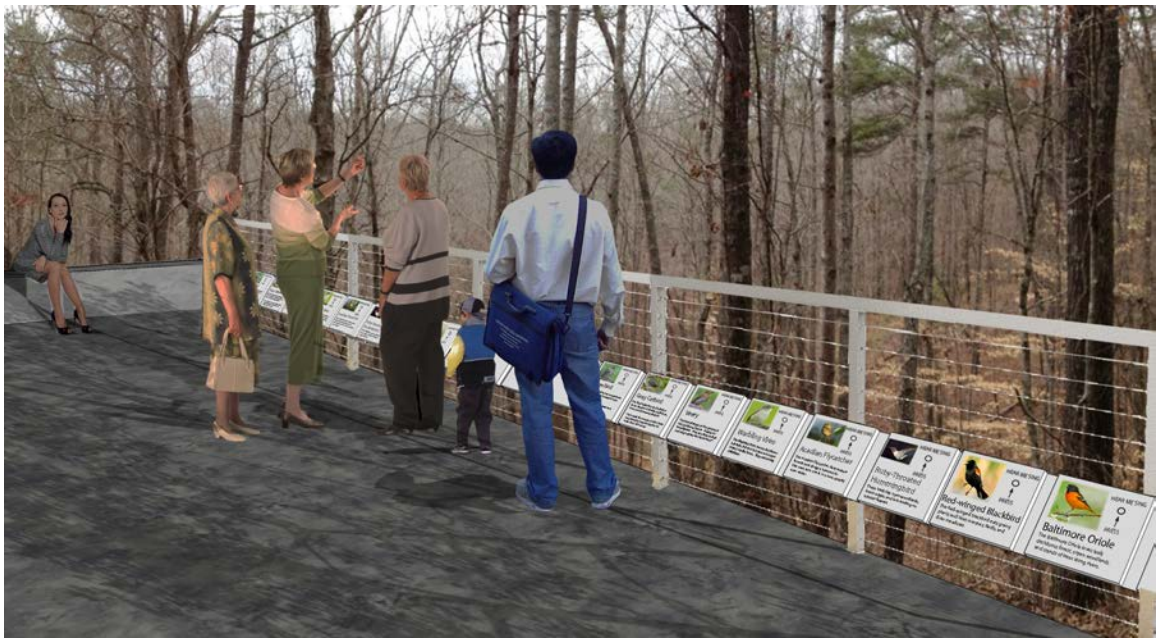

Figure 5.3 "Deck Perspective" By Author

A closer look at the display reveals that all of these birds are migratory, have been spotted in Sligo Creek Park, and are know to breed in the park as well, and that this healing garden was designed to provide these migratory birds with habitat. You had no idea that so many migratory birds used the park, and are now going from placard to

placard pressing the bird call buttons, in hopes you can listed carefully and hear one of the sounds coming from the placard out in the forest below.

The sense of extent you get by looking out over the valley provides a needed respite from the trials of life. You find this is a nice place to be, but are curious where the path off of the side of the deck leads. You reluctantly leave your new bird friends behind and explore down the path.

5.2.3 Center Perspective

The new path is bringing you to what you feel like is the center of the garden – a place almost hidden among the dense plantings that buffer any street noise.

Figure 5.4 "Center Perspective" By Author

Fortunately you see two of the three benches unoccupied and decide to have a seat to soak in the scene of the flowers swaying in the wind. A humming bird wizzes by to partake of the sweet nectar of the native tubular flowers. This is a nice place to relax, and you feel a sense of peace and a sense of 'being away.' You know that the hospital is just a few rows of plantings behind you, but you feel very removed from that reality. Sitting in a very natural spot, facing a stand of trees that fall down to stream valley, observing the shadows dancing on the paving, make you feel like your are miles from the hospital, and the worries that brought you here.

5.2.4 Waterfalls Perspective

The path curves around a blind corner, so you decide to keep exploring. As you approach

Figure 5.5 "Waterfalls Perspective" By Author

area in the healing garden, the sound of trickling water draws your interest and you approach a delightful babbling brook. This is the prettiest place you have ever been. Water is dancing over rocks falling into multiple pools. Ferns and shrubs and grasses reach out of the ground towards the sunlight. It is cooler in here. It is special in here. You are fascinated. This area reminds you of the time you went hiking and came upon a series of waterfalls and had lunch there with your friends. You feel fascinated, like you are somewhere else. You like being here. You are distracted from the stress you felt before venturing out of the cafeteria. But now it is time to go back inside, but the respite was good. You feel stronger, rejuvenated, restored. "This was a good walk," you say to yourself.

5.3 Stormwater Performance

With the addition of 7,405 SF of permeable interlocking concrete pavers, and 11,414 SF of planted areas, post intervention stormwater condition would greatly reduce the stormwater running off of the intervention area. Only 2,776 SF of impervious surfaces would remain on site, a 534% reduction in impervious surfaces, and a 278% increase in pervious surfaces.

	Existing Condition	Post Intervention	Percent Change
Impervious	14,835 SF	2,776 SF	534% decrease in impervious surface
Pervious	6,760 SF	18,819 SF	278 % increase in pervious surface
Totals	21,595 SF	21,595 SF	

Figure 5.6 "Pre and Post Intervention Impervious and Pervious Surfaces" By Author

5.3.1 Cleaner Water, and Less of It

With this new stormwater system in place, the underground piping system that drain the permeable pavers would be carrying cleaner water because the stone media in place beneath the permeable pavers filters pollutants. The permeable paver stone reservoir is capable of removing 13% - 67% of Cu, 71% - 88% of Zn, 67% of Pb, 34% - 65% of TP, and 35% to 65% of TN.[65] In addition, the bioretention area is capable of removing 43% to 67% of Cu, 71% to 88% of Zn, 64% to 87% of TP, 92% of Ammonium, and 49% of TN.[66]

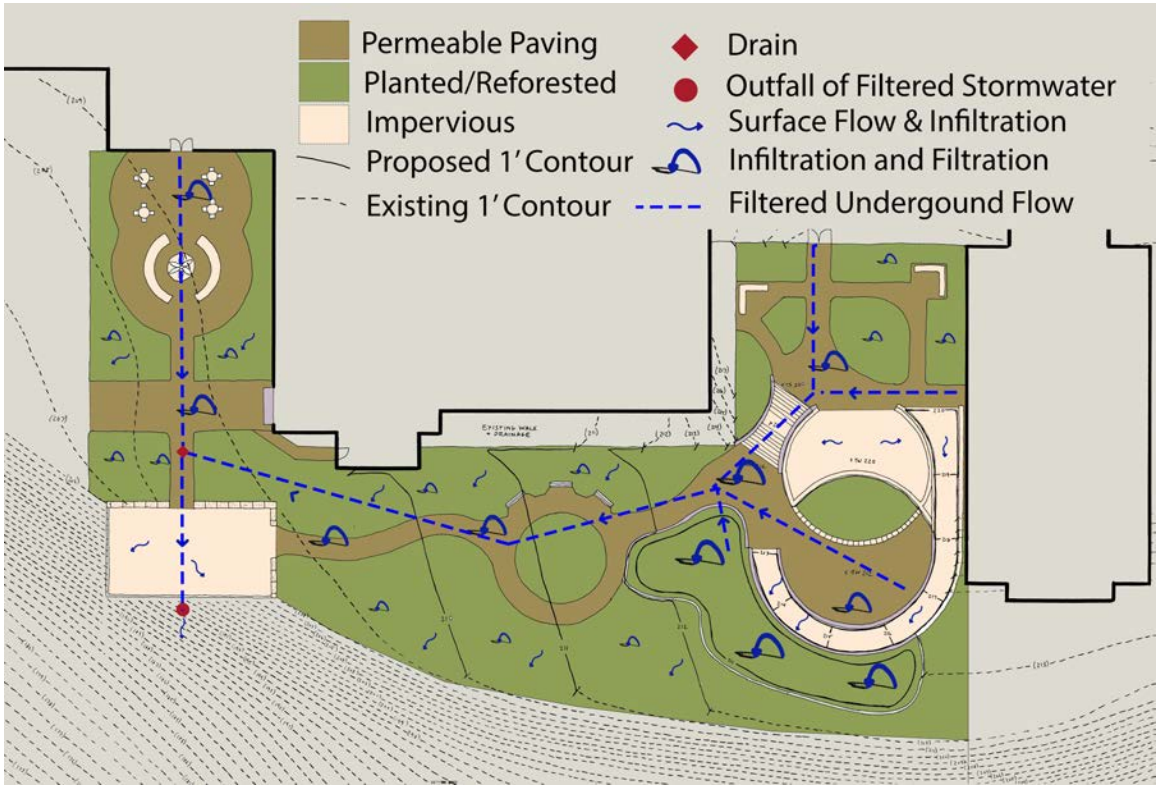

Figure 5.7 "Post Intervention Stormwater Diagram" By Author

[65] US EPA, "Permeable Interlocking Concrete Pavement."
[66] US EPA, "Bioretention (Rain Gardens)."

Not only is the water cleaner coming out of the outfall, but there is much less of it. Instead of erosive flow, the discharge on the forest slope will more resemble a trickle of much cleaner water.

5.3.2 Designing for the 100 Year, 10 Year, 2 Year and 1 Year Storms

The Virginia DEQ Stormwater Design Specification No. 7, version 2.0, published on January 1, 2013, Permeable Pavement, was referenced to size the permeable pavement reservoir.[67] The following equation from the Virginia DEQ manual to determine the depth of the stone reservoir needed was used:

$$d_{stone} = \frac{(P \times A_I \times R_{vI}) + (P \times A_p)}{n_r \times A_p}$$

Where:

d_{stone} = Depth of the stone reservoir layer (ft.)

P = The rainfall depth (in ft.) for the Treatment Volume = 7.2 inch or 0.6 ft. (this is the amount of rainfall in a 24 hr. period from the 100-yr storm)

A_I = Contributing impervious drainage area (ft^2) = 2,776 ft^2

R_{vI} = Volumetric runoff coefficient for impervious cover = .95

A_p = Area of permeable pavement (ft^2) = 7,405 ft^2

n_r = Porosity of reservoir layer = 0.4

$$d_{stone} = \frac{(.6 \text{ ft.} \times 2776 \text{ ft}^2 \times .95) + (.6 \text{ ft.} \times 7{,}405 \text{ ft}^2)}{0.4 \times 7{,}405 \text{ ft}^2}$$

d_{stone} = 2.0 ft.

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[67] Virginina Department of Environmental Quality, "Virginia DEQ Stormwater Design Specification No. 7 Permeable Pavement."

While the above calculation set the rainfall depth at 7.2 inches for the 100-year storm, the depth of the stone reservoir can be modified to accommodate smaller storms.[68]

Storm[69]	Inches of Rainfall[70]	Depth of Stone
1 Year	2.7 in.	0.76 ft.
2 Year	3.2 in.	0.92 ft.
10 Year	5.1 in.	1.44 ft.
100 Year	7.2 in.	2.0 ft.

Figure 5.8 "Depth of Stone Reservoir for Various Storms " By Author

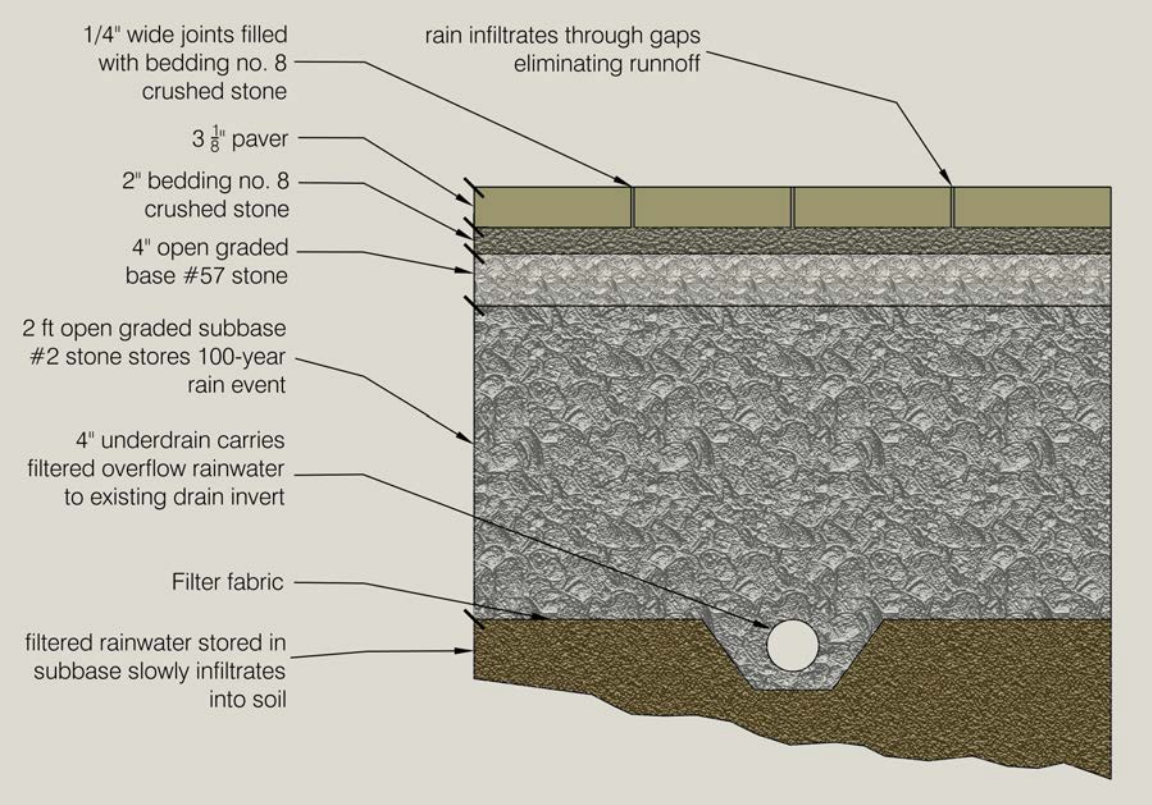

Figure 5.9 "Paver Detail for 100-Year Storm" By Author

[68] "Maryland Stormwater Design Manual."
[69] Ibid.
[70] Ibid.

CONCLUSION

What Best Management Practice stormwater mitigation techniques for Adventist Hospital's Campus would better mitigate stormwater runoff into the Sligo Creek, while providing outdoor healing spaces for the hospital community? The answer is a healing garden that is designed to capture, detain, and treat stormwater.

Hospital visitors and staff visiting the healing garden will experience the healing effects of transformative learning by learning about the migratory birds that visit and breed in the Sligo Creek Valley. Healing garden visitors will feel the restorative experiences of fascination, being away, compatibility with nature and extent by visiting the various spaces in the healing garden designed to invoke those experiential qualities.

Rain falling onto the healing garden site will not runoff as polluted stormwater negatively impacting Sligo Creek, but rather will be detained and filtered by the permeable paver system and bioretention area.

Adventist Hospital's Takoma Park campus is in a period of transition. The pending move to White Oak comes with it an opportunity to rethink how its landscape will service a new vision for the Takoma Park Campus. It is my hope this design will add to a rich conversation about what the future holds for the hospital's Takoma Park Campus. Whatever the programming of this land becomes, it is clear that we have the ability to create a landscape that respects and nurtures its relationship to Sligo Creek, to the

community the hospital serves and to the wildlife of the Sligo Creek Valley, from which we have taken so much.

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