BIOPHILIC PLAYSPACE DESIGN: BRINGING TOGETHER

CHILDREN AND NATURE IN URBAN HONOLULU

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Dedication

In loving memory of my mother, Leila.

Abstract

The purpose of this study is to provide innovative design criteria for urban playgrounds based on the principles of biophilic design. Derived from the biophilia hypothesis, biophilic design aims to provide humans with a positive contact with nature in a built environment. The biophilia hypothesis asserts that human's attachment with nature is a biological need, and it was used as a framework to demonstrate the crucial importance of a connection between humans and nature. The relationship between children and nature was explored through empirical studies, which reveal the importance of this connection for children's health. The analyses of empirical studies demonstrate children's preferences for spaces to play, which reinforces the idea that children like to play in natural environments.

The playground's design overview was explored and it reveals that the design of many playgrounds today do not support children's overall development as they once did. Understanding that safety concerns became the primary driver for the design of the majority of contemporary playgrounds within the U.S., biophilic design is proposed as the basis for alternative guidelines to be applied to the design of playgrounds to benefit children. Based on the analysis of children's preferred spaces in which to play, sixteen biophilic design principles were selected as ideal to be applied to the overall playground site design and specific play elements of the playground.

Due to the relative lack of available natural space in dense urban cities, private or public vacant lots were considered as available and a dense neighborhood in Honolulu was chosen for the application of this study. Through critical spatial analysis, vacant—or available—lots were identified as potential sites to apply this design. The spatial investigations of the biophilic design principles revealed opportunities to apply them to the overall playground site design and specific play elements of the playground.

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1 Chapter 1. Introduction

By 2030, there will be 41 megacities—very large cities typically with a population of over 10 million inhabitants.[1] By 2050, 7 in 10 people will live in urban areas such as these cities,[2] and statistics show that people are moving from natural to urban settings at an unprecedented pace.[3] This growing tendency is aggravated by overall population growth. Thus, cities are reducing green spaces in favor of built spaces.[4] As such, urbanization is largely responsible for the scarcity of green spaces in dense urban cities, and this reality is negatively affecting the health of children, who are generally lacking this contact.[5] The biophilia hypothesis states that human beings have an instinctive tendency to be in contact with nature.[6] Limiting a person's contact with nature during childhood might, in fact, increase the chances that, as an adult, he or she will not value the importance of nature,[7] thus not allowing one to reap the overall benefits that come when one interacts with nature.

Children who live in modern dense urban cities are often lacking attractive available spaces in which to play in contact with nature.[8] Urban parks and neighborhood playgrounds are usually the main option for them; however, urban parks are not equally distributed within a city, which results

[1] Demographia, "Demographia: Built Up Urban Areas of World Agglomerations, 13th Annual Edition," World Urban Areas, no. 04 (April 2017): 6, http://www.demographia.com/db-worldua.pdf.
[2] United Nations Children's Fund (UNICEF), "Children in an Urban World," The State of the World's Children, February 2012: 14, https://www.unicef.org/sowc/files/SOWC_2012-Main_Report_EN_21Dec2011.pdf.
[3] United Nations Fund for Population Activities (UNFPA), "Population dynamics and policy implications: Urbanization," Population Dynamics in the Post-2015 Development Agenda: Report of the Global Thematic Consultation on Population Dynamics, 2014: 10–27, http://www.unfpa.org/sites/default/files/pub-pdf/Population%20Dynamics%20in%20Post-2015%20FINAL.pdf.
[4] http://unhabitat.org/urban-themes/planning-and-design/
[5] Rhonda Clements, "An Investigation of the Status of Outdoor Play," *Contemporary Issues in Early Childhood* 5, no. 1 (March 2004), 68–76.
[6] Edward O. Wilson, *Biophilia* (Cambridge, MA: Harvard University Press, 1984), 1.
[7] Weizhe Zhang, Eben Goodale, and Jin Chen, "How Contact with Nature Affects Children's Biophilia, Biophobia and Conservation Attitude in China," *Biological Conservation*, no. 177 (September 2014): 109-116, https://doi.org/10.1016/j.biocon.2014.06.011.
[8] Louv, *Last Child in the Woods*, 64.

in inequitable access to green areas.[9] [10] The majority of public playgrounds today are not the attractive and educational places that they used to be.[11] Playgrounds used to be spaces for children's cognitive learning and parents' social interactions, but the majority of public playgrounds today are not wholly integrated with nature and lack spaces for social interaction. [12] At its core, biophilic design seeks to positively integrate elements of nature within a built environment.

My hypothesis is that by employing biophilic principles within the design of a playground in dense urban areas, architects can promote the opportunity for daily interaction with natural elements and consequently be more proactive in fostering the physical, psychological, and emotional wellbeing in children. This study will explore opportunities to apply the concept of biophilic design to vacant or underutilized lots to promote opportunities for urban dwelling children to play in contact with nature.

As a patchwork with gaps, the city's urban fabric has spaces that are vacant and underutilized. These urban spaces, however, can provide opportunities for nature to fill the gaps. The review of current literature demonstrates the deficiency of attractive and fully accessible outdoor urban spaces in which children can play in contact with nature. Through the application of biophilic design, small public yet vacant or underutilized spaces might allow for the creation of playgrounds for children to experience daily contact with nature. Biophilic design applied to the design of playgrounds can help to promote the connection between humans and nature, as well as serving

[9] Robert Michael Pyle, "Eden in a Vacant Lot: Special Places, Species, and Kids in Community of Life." *Australasian Parks & Leisure* 11, no.3 (Spring 2012): 6, EBSCOhost.
[10] Jennifer R. Wolch, Jason Byrne, and Joshua P. Newell, "Urban Green Space, Public Health, and Environmental Justice: The Challenge of Making Cities 'Just Green Enough,'" *Landscape and Urban Planning* 125, (May 2014): 234–244,https://doi.org/10.1016/j.landurbplan.2014.01.017.
[11] Susan G. Solomon, *American Playgrounds: Revitalizing Community Space* (Lebanon, NH: University Press of New England, 2005), 2.
[12] Amy Ogata, "American Playgrounds: Revitalizing Community Space," *Design Issues* 26, no. 2 (Spring 2010): 82–3, https://doi.org/10.1162/DESI_r_00008.

as a node of connectivity for the respective community. In addition, such playgrounds can potentially restore degraded areas and function as green infrastructure for a more sustainable city.[13]

Small public and/or private spaces (vacant and/or underutilized available lots) in a dense urban area of Honolulu can be used as potential sites for public playgrounds. The concluding proposal within this study will, then, be that the application of biophilic design into the creation of a public playground for urban-dwelling children will allow children and others to play in contact with and interact with nature. With the ultimate goal of enhancing children's physical, psychological, and emotional health by exposing them to natural elements, the focus of this study is to explore the biophilic design principles when applied to the design of contemporary playgrounds in dense areas within cities.

1.1 Research Questions

Urbanization is largely overtaking green spaces, and children who live in urban cities are increasingly lacking easy access to such natural areas in which to play. According to the United States Environmental Protection Agency (EPA), vacant lots can be problematic spaces for those living and working urban communities if used illegally as a space for dumping trash, especially if these lots become contaminated with hazardous substances. However, vacant and underutilized lots are unused spaces that are spread out within an urban fabric and, as such, can exist as ideal locations to insert playgrounds for children and to design these playgrounds so as to increase contact with natural elements. Biophilic design promotes a positive connection between humans and nature in a built environment. Hence, this study aims to answer the following questions:

[13] Karin Kragsig Peschardt and Ulrika Karlsson Stigsdotter, "Evidence for Designing Health Promoting Pocket Parks," *International Journal of Architectural Research* 8, no. 3 (November 2014): 149-164, ResearchGate.

How does one provide daily contact with nature for children in dense urban areas where nature is often scarce? How can playground be an opportunity to connect children with nature in dense urban cities. And how can biophilic design be applied into the overall design of playgrounds so as to be beneficial for urban-dwelling children?

1.2 Research Methodology

A literature review was conducted to explore and identify the connection between nature and human development, described as biophilia hypothesis, which is being negatively affected by urbanization. This exploration and identification, then, led to further research regarding the effect that nature has on children. In addition the environments for play were analyzed. The history of playgrounds was studied in order to understand how and why playground design changed over time. This information helped establish new design parameters, presented within this study, based on contemporary issues.

Spatial analysis of urban Honolulu was used through ArcGIS and Google Earth to identify neighborhoods that meet the site selection criteria. Once a specific neighborhood was selected, vacant and underutilized lots were identified and considered available through analyzing the City of Honolulu Transit Development Plan (TOD) and Google Maps and were further examined in person by walking through the area. Potential sites were documented through notes and photographs. The final selection of a playground site was made based on a ranking matrix that determined which site had the most potential to impact the greatest number of children.

2 Chapter 2. Literature Review

This literature review demonstrates the importance of contact with nature for children's development and for their overall health and wellbeing. The *Biophilia Hypothesis* exists as a framework asserting that contact with nature is a human biological need, and the connection between children and nature is a crucial aspect of our health. Empirical research demonstrates the importance for children to play in contact with nature and also reveals their preference for natural environments. Playgrounds can provide an opportunity for children to connect with nature within a city, but the design of most conventional contemporary "playgrounds" does not adequately allow for this connection. The history of playgrounds reveals how and why the design of spaces for children to play has changed over time. The purpose of this review is to explore how biophilic design may be applied on a design of playgrounds to positively insert green spaces into urban environments.

2.1 Biophilia

It is common to see people who live in dense urban centers seeking contact with nature so as to reduce stress. This behavior was originally recognized in the early 1900s by German philosopher Erich Fromm and gained renewed popularity in 1984 with American biologist Edward O. Wilson's book *Biophilia*.[14] Wilson defines "biophilia" as a natural inclination that humans have to be in contact with nature. He suggests that it is a biological need and an evolutionary process that has its roots on the primitive eras of human development and still imprinted in our genes today.[15] By recognizing the biophilia hypothesis as a "primordial human biological need," it is imperative that

[14] Stephen R. Kellert and Edward O. Wilson, eds., *The Biophilia Hypothesis* (Washington, DC: Island Press, 1993), 31.
[15] Stephen R. Kellert and Edward O. Wilson, eds., *The Biophilia Hypothesis* (Washington, DC: Island Press, 1993), 21.

we seek to promote greater human contact with the natural environment in urban cities where nature is often scarce because it is where the majority of the U.S. population is concentrated today.[16]

A negative response to nature is known as *biophobia* versus *biophilia* and entails an aversion from threatening aspects of nature.[17] The *biophilia hypothesis* suggests that this connection (positive or negative) was created because of the fact that the human evolutionary process was developed in a natural environment. According to this hypothesis, humans were exposed to natural settings compelling them to learn how to live under nature's often-hostile conditions. For example, in nomadic times, humans were attracted to water and trees but afraid of snakes and darkness.[18] The biophilia hypothesis states that positive contact with nature is indispensable in regards to the physical and psychological health of human beings, and deprivation can result in an unsatisfactory life.[19] However, dense urban cities lack green spaces in favor of built spaces[20,21.] Consequently people who live in such city spaces have fewer opportunities to satisfy the primordial biological need for biophilia.

There exists growing empirical and theoretical evidence showing the physical and psychological benefits provided to human beings through contact with nature. Attention Restoration Theory (ART) supports the idea that contact with nature has an influence on attentional functioning of

[16] UNFPA, "Population dynamics and policy implications," 6–27.
[17] Kellert and Wilson, *The Biophilia Hypothesis*, 78–86.
[18] Ibid.
[19] Peter H. Kahn, "Developmental Psychology and the Biophilia Hypothesis: Children's Affiliation with Nature," *Developmental Review* 17, no. 1 (1997): 1–61, https://doi.org/10.1006/drev.1996.0430.
[20] Talukder Byomkesh, Nobukazu Nakagoshi, and Ashraf M. Dewan "Urbanization and Green Space Dynamics in Greater Dhaka, Bangladesh," *Landscape and Ecological Engineering* 8, no. 1 (February 2011): 45–58, https://doi.org/10.1007/s11355-010-0147-7.
[21] Fanhua Kong and Nobukazu Nakagoshi, "Spatial-temporal Gradient Analysis of Urban Green Spaces in Jinan, China." *Landscape and Urban Planning* 78, no. 3 (November 2006): 147–164, https://doi.org/10.1016/j.landurbplan.2005.07.006.

people—a basic cognitive process.[22] According to ART theory, contact with nature has the ability to restore cognitive abilities and renew attention.[23] *Directed attention* is defined as the ability to focus on a determined task and process sensory information properly. However, this capacity for directed attention can be impaired due to excessive concentration on a given object or situation and can develop into fatigue, resulting in loss of memory, difficulty focusing one's attention, and stress regarding the development of human relationships.[24] In 1981, a significant study investigated the positive effects on stress reduction when one is within a natural environment in comparison to an urban environment.[25] Through this study, 120 individuals were exposed to six different color/sound videos with images of, both, natural (water and vegetation) and urban settings (without water or vegetation). Following the individual viewings, physiological measures (e.g. heartbeat, blood pressure, and skin conductance) and verbal measures (e.g. semantic questionnaire to measure mood and feelings) were obtained. The results showed that individuals recovered more quickly when exposed to images of nature versus an urban environment.

Another example of the beneficial contact with nature was observed in a study conducted by the University of Illinois in dense urban areas of Chicago. The 2001 study focused on urban public housing and considered places with high rates of human aggression toward others. This study analyzed 145 individuals according to their respective levels of stress and the various levels of connection to nearby nature. The results demonstrate that individuals with more contact with nature (e.g. views of trees or grass) reported less aggression. This study suggests that contact with nature alleviates psychological fatigue helping reduce feelings of aggression and the

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[22] Stephen Kaplan, "The Restorative Benefits of Nature: Toward an Integrative Framework," *Journal of Environmental Psychology* 15, no. 3 (September 1995): 169–82, https://doi.org/10.1016/0272-4944(95)90001-2.
[23] Ibid.
[24] Kaplan, "The Restorative Benefits," 169–82.
[25] Roger S. Ulrich, "Natural Versus Urban Scenes: Some Psychophysiological Effects," *Environment and Behavior* 13, no. 5 (September 1981): 523–56, https://doi.org/10.1177/0013916581135001.

potential expression of violence for inner-city residents.[26] In another study conducted throughout nine cities in Sweden with 953 randomly selected individuals to determine how stress and stress-related wellness is related to their urban living.[27] A questionnaire about each individual's use of nearby green urban spaces and their overall physical and psychological health was given to each participant. The results revealed a significant association between the use of green spaces in a city and the recounted experiences of stress. The findings demonstrated that the more often individuals visit green spaces, the fewer incidents they reported suffering from stress-related effects. The travel distance to reach public green spaces was also considered as a decisive aspect for individuals' use of the green spaces. The conclusion was that city landscape planning has the potential to affect the respective health of urban-space-dwelling individuals.

2.1.1 Biophilia and Children

Place attachment is a primary concept within the field of environmental psychology that considers how a positive connection to a specific location is established throughout one's childhood.[28] According to Stephen R. Kellert, a professor emeritus of Social Ecology at Yale University's School of Forestry and Environmental Studies, "nature appreciation" begins during childhood when this contact with nature is considered the most important for an individual's development.[29] Similarly, Peter H. Kahn, Jr., a professor in the Department of Psychology and Director of the Human Interaction with Nature and Technological Systems Laboratory at the University of Washington, proposes that the dislike for nature also begins during childhood and he suggest that

[26] Frances E. Kuo and William C. Sullivan, "Aggression and Violence in the Inner City: Effects of Environment via Mental Fatigue," *Environment and Behavior* 33, no. 4 (July 2001): 543–71, https://doi.org/10.1177/00139160121973124.
[27] Patrik Grahn and Ulrika A. Stigsdotter, "Landscape Planning and Stress," *Urban Forestry & Urban Greening* 2, no. 1 (2003): 1–18, https://doi.org/10.1078/1618-8667-00019.
[28] Louise Chawla, "Childhood Place Attachments," in Place Attachment: Advances in Theory, Methods and Applications, eds. Lynne C. Manzo and Patrick Devine-Wright (Abingdon, UK: Routledge, 2016), 63–86.
[29] Peter H. Kahn and Stephen R. Kellert, eds., *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations* (Cambridge, MA: MIT Press, 2002), 93–117.

it is a time when children's positive contact with nature should be encouraged in order for individuals to develop an "appreciation" instead of "aversion" to the natural world.[30] In other words, if human beings do not expose children to a positive natural environment, individuals might grow up to be adults who will dislike contact with nature. To understand the extent to which this appreciation for nature is established in an individual's formative years and to measure children's tendency toward biophilia or biophobia, a study was conducted in 2012 by researchers at the University of Chinese Academy of Sciences in China. [31] Within this study, 15 elementary schools, with different degrees of urbanization, were selected. Then, a total of 1119 children between the ages of 9 and 10 were asked to fill out questionnaires reporting the occurrences of their outdoor activity. The data was, then, compiled to measure children's overall exposure to nature. Twelve examples of a common wild animal found in the country of China (e.g. mammals, birds, reptiles, amphibians, spiders, and insects) were shown to participants in order to observe each child's respective biophilia or biophobia. The results demonstrated that children from rural schools, who had more contact with nature than children from urban schools, have a more positive inclination to develop the positive biophilia than biophobia.

2.1.2 Children and Nature

Studies demonstrate that children have a preferences for natural settings.[32, 33] Evidence shows that children exposed to a positive natural environmental have better physical, psychological, and emotional maturation.[34] In addition, children who play in a natural environment have stronger creative and cognitive abilities, along with better language development and more

[30] Peter H. Kahn, *The Human Relationship with Nature: Development and Culture* (Cambridge, MA: MIT Press, 1999), 31–36.
[31] Zhang, Goodale, and Chen, "How Contact," 109–16.
[32] K. Korpela, "Children's Environment," in *Handbook of Environmental Psychology*, eds. R. B. Bechtel and A. Churchman (NY, NY: John Wiley & Sons, 2002), 363–73.
[33] Robin C. Moore, *Childhood's Domain: Play and Place in Child Development* (London, UK: Croom Helm Ltd, 1986), 40–44.
[34] Kahn and Kellert, *Children and Nature*, 117–146.

independence.[35] Even small amounts of time within a natural setting have the ability to promote restoration and reduce stress.[36, 37] Nearby accessibility to nature, in regards to their respective homes, is believed to be beneficial for children's physical, psychological, and emotional wellbeing. Nature has the capacity to buffer the negative effects of stressful situations in children's lives. This "buffer effect" is interpreted as nature's ability to reduce the negative effects of stressors on children. This natural buffering hypothesis was first suggested in 2003 by Nancy M. Wells and Gary W. Evans in one of the most significant studies regarding nature's capacity to work as a buffer for children's stress.[38] In this study, the authors propose that children who live in a more natural environment have lower levels of stress in comparison to children who lack contact with nature. Data was collected from 337 children in grades 3 through 5 from small towns in 5 rural upstate New York communities. The analysis was meant to measure nature's buffer or moderator impact regarding stressful situations and children's psychological wellbeing. See Figure 01. In this study, two standardized measures of psychological distress, one report from mothers and a child self-report, were applied to measure the occurrence of stressful events in the children's lives. The conclusion was that children with frequent exposure to nearby nature have a lower impact of life stress than children with lesser exposure to nature.

[35] Louv, *Last Child in the Woods*, 85–97.
[36] Timothy Beatley, *Biophilic Cities: Integrating Nature into Urban Design and Planning* (Washington, DC: Island Press, 2011), 5.
[37] José A. Corraliza, Silvia Collado, and Lisbeth Bethelmy, "Nature as a Moderator of Stress in Urban Children," *Procedia - Social and Behavioral Sciences* 38, 2012: 253–63, https://doi.org/10.1016/j.sbspro.2012.03.347.
[38] Nancy M. Wells and Gary W. Evans, "Nearby Nature: A Buffer of Life Stress among Rural Children," *Environment and Behavior* 35, no. 3 (2003): 311–30, https://doi.org/10.1177/0013916503035003001.

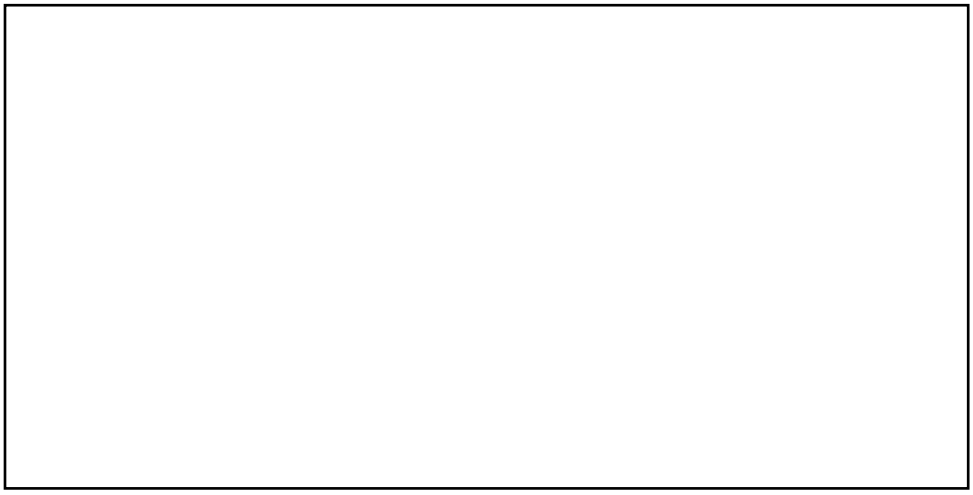

Figure 1. Nature Moderates Effects of Stressful Life Events on Psychological Distress.

An empirical study conducted by Faculties of Psychology, José A. Corraliza, Silvia Collado, and Lisbeth Bethelmy from Universidad Autonoma de Madrid in Madrid, Spain, in 2012, demonstrated that schools and homes near natural spaces have a moderator effect on children's stress.[39] Interviews with 172 children (53% boys and 47% girls) ages 10 to 13 were conducted, and data was collected to show the relationship between children's respective stress levels, the frequency of exposure to stressful situation, and the perception regarding the amount of perceived natural spaces around them. This study evaluated the amount of nature present in residential and school areas—places where children spend the majority of their time each day.

Four primary schools were chosen according to the amount of nature within them. Schools were classified into four categories: "very natural," "natural," "medium amount of nature," and "non-natural." In addition, the natural elements of the children's homes were measured. The outcomes show that the amount of nature that children perceive in the school has a positive influence on children's stress level. The results suggest that nearby available nature has the potential to act as a moderator to the negative effects caused by children's stressful events. This study reinforces

[39] Corraliza, Collado, and Bethelmy, "Nature as a Moderator," 253–63.

the idea that children who live in urban areas but who have daily contact with nature deal better with any given stressful situation.

Another significant benefit of close contact with nature is described in a study conducted in 2002 by Andrea Faber Taylor, Frances E. Kuo, and William C. Sullivan from University of Illinois Urbana-Champaign, in the U.S. Their research investigated the relationship between nearby contact with nature and children's self-discipline.[40] According to the authors, self-discipline is largely related to children's respective academic achievements, among other significant aspects of their development and is a noteworthy virtue that an individual can achieve with "directed attention"—a quality that is considered scarce within individuals but one that can be restored through contact with nature. In this study, three forms of self-discipline were considered: concentration, inhibition of initial impulses, and delay of gratification. A total of 169 inner-city boys and girls, between ages 5 and 14 years old who lived in Robert Taylor Homes (a large public housing development in Chicago, Illinois) were randomly selected from 12 identical buildings with differing amounts of natural elements. To make sure that trees could be seen from the buildings, lower level apartments (i.e. 2nd, 3rd, and 4th floors) were chosen for the study. See Figure 2.

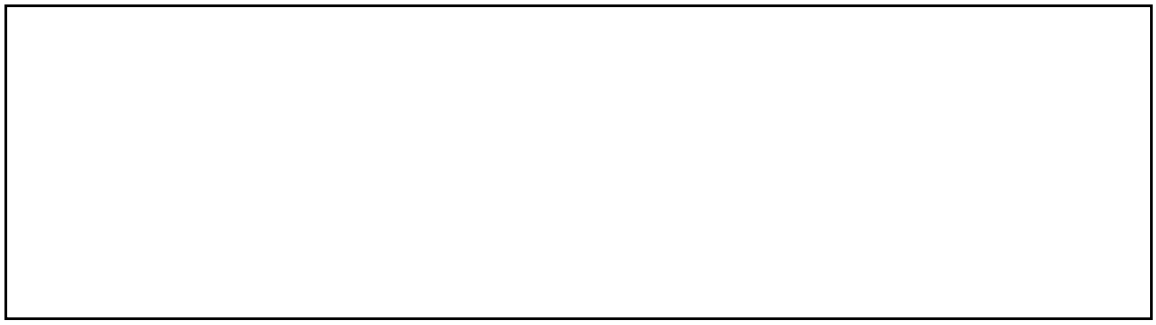

Figure 2. Views of nature vary from apartment to apartment at Robert Taylor Homes.

[40] Andrea Faber Taylor, Frances E. Kuo, and William C. Sullivan, "Views of Nature and Self- Discipline: Evidence from Inner City Children," *Journal of Environmental Psychology* 22, no. 1–2 (June 2002): 49–63, https://doi.org/10.1006/jevp.2001.0241.

The results from this research showed that children who live in buildings that have views of trees have higher levels of attention, lower levels of hostility and reported crime, and higher levels of self-discipline. This study conducted with inner-city children in Chicago concluded that contact with nature, even if is indirect contact with nature (e.g., a view from a window) can be beneficial to children's overall health and wellbeing.

According to the American Psychiatry Association, an estimated 6.4 million children in the United States suffer from Attention Deficit Hyperactivity Disorder (ADHD).[41] The influence of the environment on attentional functioning was measured in children with ADHD. In a study conducted in 2009 by Andrea Faber Taylor and Frances E. Kuo, from University of Illinois, Urbana-Champaign, seventeen children from 7 to 12 years old who had been diagnosed with ADHD were exposed to 20 minutes of walking within three different environments: one urban park and two urban settings (downtown and neighborhood areas).[42] After each walk, concentration was measured, and the results demonstrated that the children had better overall concentration after a walk in the park versus a walk within a wholly urban setting.

A variety of ways exist in which children can have contact with nature, and each of these forms can benefit various aspects of children's development.[43] According to Kellert, nature can be experienced in three ways: "direct, indirect, and vicarious."[44] Kellert defines direct experience with nature as when one's physical contact with natural elements or with a nonhuman animal species when it occurs in a spontaneous way and is not dependable on humans' built environment. For example, children can experience direct contact with nature in a nearby forest, in a park, or in a backyard with trees, animals, and other natural elements. With indirect contact with nature, children can have a physical interaction or experience with natural elements but in a planned and

[41] http://www.apa.org.
[42] Andrea Faber Taylor and Francis E. Kuo, "Children with Attention Deficits Concentrate Better after Walk in the Park," *Journal of Attention Disorders* 12, no. 5 (March 2009): 402–09, https://doi.org/10.1177/1087054708323000.
[43] Kahn and Kellert, *Children and Nature*, 124.
[44] Ibid.

restricted manner with the involvement of human activity and intervention. For example, children can have “natural” encounters in zoos, museums, aquariums, or even with domesticated animals in natural settings that include human intervention. On the contrary, with a vicarious or "symbolic" experience, there is no physical contact involved with elements of nature, but, instead, a symbolic or representation of it is given (e.g. depicted scenes of natural elements and settings on television, in film, on a computer screen, or in a book). Vicarious and virtual experiences with nature can compensate for the lack of direct contact with natural settings, and all three ways of experiencing nature are directly related to childhood development. [45]

Evidence exists showing how children are spending less time within natural settings and more time indoors.[46] This evidence could be an indicator that children are experiencing less direct and more indirect and vicarious contact with nature. Given the significance of the interconnection of these three aspects (i.e. direct, indirect, and vicarious) regarding exposure to nature for the good of overall child development, the lack of direct exposure to healthy and abundant natural settings can be a problematic issue.[47] Knowing the importance of direct exposure to nature can allow human beings to create more opportunities for children to experience this direct contact with nature in a built environment. Playtime might be an ideal occasion to expose children to natural environments. However, what are children’s preferences regarding spaces in which to play? Do children like to play in a more natural or built environment? Is playtime the best time to expose children to natural elements? To answer these questions, it is necessary to investigate children’s playtime behaviors and preferences of spaces in which to play.

[45] Pyle, “Eden in a Vacant Lot,” 305–327.
[46] Clements, "An Investigation of the Status of Outdoor Play," 68–80.
[47] Kahn and Kellert, *Children and Nature*, 118–130.

2.1.3 Children and Play

The periods of each day generally referred to as “playtime” for children should not just be considered as time for personal recreation. Instead, the establishment of such playtime every day for a child, regardless of his or her global location, is a crucial element of children’s mental, physical and emotional development.[48] Such is the importance of play in children’s lives that it is considered by the United Nations of High Commission for Human Rights as a "right of every child."[49] Children prefer to play in natural settings versus standard playground structures**.** [50] When in natural settings, children are exposed to natural materials (e.g. flowers, sticks, and stones), which have been shown to stimulate their creativity and imagination—significant aspects of children's social and cognitive behaviors.[51] Imaginative play is considered especially important regarding child development, as it affects a child’s physical, cognitive, social, and emotional wellbeing. [52] It is during playtime that children have the opportunity to explore the world that surrounds them using their creativity and to better develop social, mental and physical aspects of their life.[53]

Children used to play outside the home and in outdoor environments more frequently, but more recently that has changed. Further, children in a dense urban setting are often surrounded by asphalt and concrete and presented with too few opportunities to experiment and explore natural environments in their everyday life.[54] In 2005, a journalist and co-founder of Children & Nature Network, Richard Louv, in his book *Last Child in the Woods*, argues that children are suffering

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[48] "Lev Vygotsky's Cognitive Development Theory and the Benefits of Play." http://www.childdevelopmentmedia.com/articles/play-the-work-of-lev-vygotsky/.
[49] http://www.ohchr.org/en/professionalinterest/pages/crc.aspx
[50] Korpela, “Children’s Environment,” 363–373.
[51] Kahn and Kellert, *Children and Nature*, 305–312.
[52] Kenneth R. Ginsburg, "The Importance of Play in Promoting Healthy Child Development and Maintaining Strong Parent-Child Bonds," *Pediatrics* 119, no.1 (January 2007): 182–91, http://dx.doi.org/10.1542/peds. 2006–2697.
[53] Kahn and Kellert, *Children and Nature*, 45-47.
[54] Louv, *Last Child in the Woods*, 61.

from what he called “nature deficit disorder.”[55] Louv claims that children who live in dense urban cities largely experience a lack of contact with nature and consequently all the respective benefits. In one sense, he blames parents who overprotect their children through what he calls the "bogeyman syndrome."[56] He argues that this overprotection contributes to keeping children separated from nature on a daily basis and asserts that this “syndrome” is further complicated by the addition of young people's’ dependency on electronic media.

Within contemporary society, time to relax and play has become an increasingly scarce resource, and many parents do not have available drive time to take their children to play in parks or playgrounds. Green, recreational areas are also often far apart from one another. And in large urban areas, relatively few children living there have the privilege of a park close to home.[57] Therefore, children who live in these areas often spend a considerable amount of time indoors playing video games, which, ironically, could be the most detrimental of options for their respective physical, mental, and emotional wellbeing.

A study conducted in 2004 by Professor Rhonda Clements, program director for the physical education and sport pedagogy master's program at Manhattan Ville College’s Harrison School of Education showed that, in the United States, children spend significant less time playing outdoors than did those children within the previous generation.[58] According to worldwide research conducted in 2016 by Edelman Berland—a global, market research and analytics firm and the world’s largest public relations company, for the Unilever—a Dutch-British transnational consumer goods company, children within the United States are spending “less time outdoors than prison inmates.”[59] The UN Standard Minimum Rules for the Treatment of Prisoners require

[55] Louv, *Last Child in the Woods*, 99.
[56] *Louv, Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder, 126.*
[57] *Louv, Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder, 141.*
[58] Clements, "An Investigation of the Status of Outdoor Play," 68–80.
[59] “Why Dirt is Good,” Dirt is Good, http://www.dirtisgood.com/uk/truth-about-dirt.html.

"at least one hour of suitable exercise in the open air daily."[60] Berland surveyed 12,000 parents in 10 different countries with children from 5 to 12 years and determined that one-third of children have less than 30 minutes of outside exposure each day. Considering the impact of child development through their respective playing in contact with a natural environment, it is a viable argument that children's development could be impaired and diminished due to urbanization.

2.1.4 Children's Preferences for Places to Play

Human beings often favor to be close to natural places.[61] To be clear about children's preferences for places to play, a study of 40 children from 6 to 12 years old was conducted in a poor neighborhood of Tehran, Iran, by individuals from the School of Architecture and Environmental Design in Iran and University of Science and Technology in Tehran, Iran.[62] Researchers Sharareh Ghanbari-Azarneir, Sara Anbari, Seyed-Bagher Hosseini, Seyed-Abbas Yazdanfar found that the high-density characteristics of the Farahzad neighborhood and the lack of green spaces in which children are able to play forced children to spend their play time on streets and in alleys, clearly not designed for children's play and, therefore, not safe for them. In order to understand children's preferences, the researchers asked participating children to draw pictures of their favorite play environments. Individual interviews were conducted to complete the data based on these children's drawings, and their drawings were interpreted by child psychologists. In addition to the drawings and interviews, a field study was conducted to identify spaces in neighborhoods with potential for children's play-based activities. See Figure 3.

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[60] "Standard Minimum Rules for the Treatment of Prisoners," United Nations Office on Drugs and Crime, https://www.unodc.org/pdf/criminal_justice/UN_Standard_Minimum_Rules_for_the_Treatment_of_Prisoners.pdf.

[61] Kahn and Kellert, *Children and Nature*, 1.

[62] Sharareh Ghanbari-Azarneir, Sara Anbar, Seyed-Bagher Hosseini, and Seyed-Abbas Yazdanfar, "Identification of Child-Friendly Environments in Poor Neighborhoods," *Procedia - Social and Behavioral Sciences* 201, (August 2015): 19–29, https://doi.org/10.1016/j.sbspro.2015.08.114.

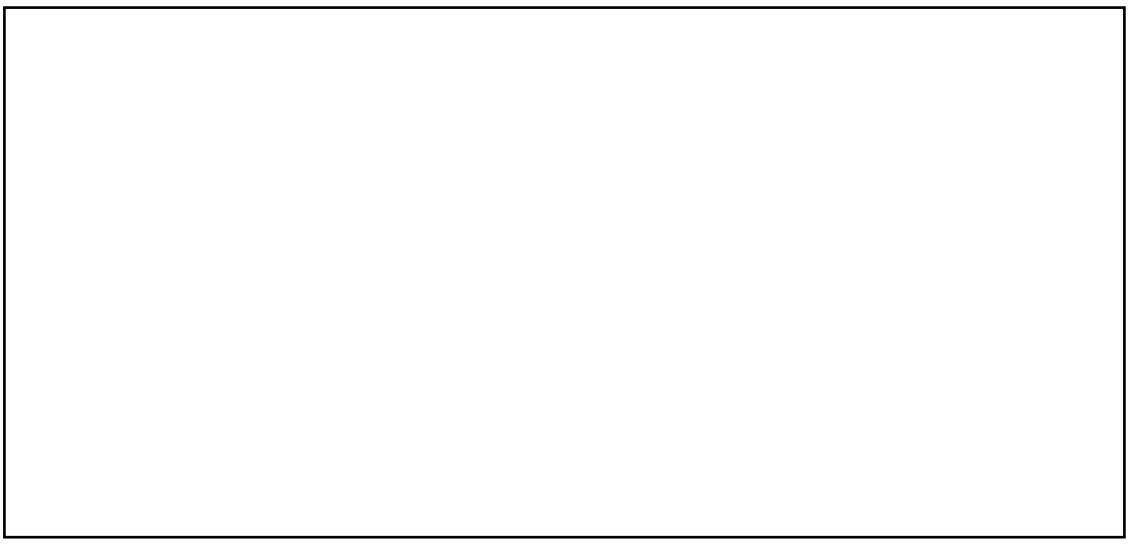

Figure 3. Children Play Activities in the Farahzad Neighborhood.

The data collected from the paintings and interviews were categorized into six subcategories. See Table 1. The results showed that children preferred places that contain natural elements like trees, flowers, animals, and, in some cases, water in their play areas.

Table 1. Subcategories Found in Paintings and Interviews.

Subcategories	Paintings	Frequency	Interviews
Parks & playgrounds	Sports fields Playground settings Flowers and trees	18 33 35	Golpad Park
Streets & alleys	Yards Exterior of the house	33 30	Children home Acquaintance home
Houses	Cars	5	Slope surfaces Flat surfaces
People	Playmate	39	Friends Family members
Toys & playthings	Marbles Balls Bicycles Dolls	2 10 3 3	Video games Playing cards Bricks Tires
Animals	Butterfly Horse Bird Fish	5 1 4 3	
Public places	Park	1	Baharan bridge

In this poor neighborhood, safety was a primary concern and preferred places to play were those nearby a child's home or a friend's home. In addition to the playground, flat or low-sloping alleys and cul-de-sacs were chosen as preferred spaces for play. See Figure 4.

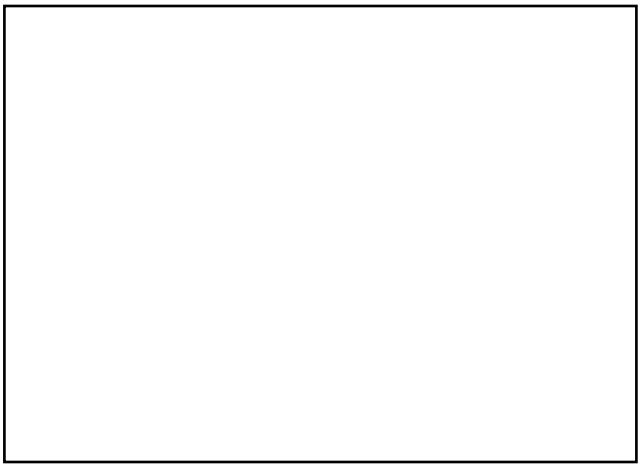

Figure 4. Children's Drawing of Playing Football Between Two Houses (Reproduced from Ghanbari-Azarneir et al., "Identification of Child-Friendly Environments in Poor Neighborhoods.").

All children included at least one playmate within their drawings. According to the psychologists who analyzed the drawings, they determined that the drawings demonstrate that children like to socialize within a play environment. See Figure 5 and Figure 6. Contrarily, representations of parents do not appear within the children's drawings, which suggested to the researchers that the children either do not like to play under a parent's supervision, that they prefer playing with children versus adults, or that they simply do not feel the need to depict adults within a space designed for children's play, among other possible reasons.

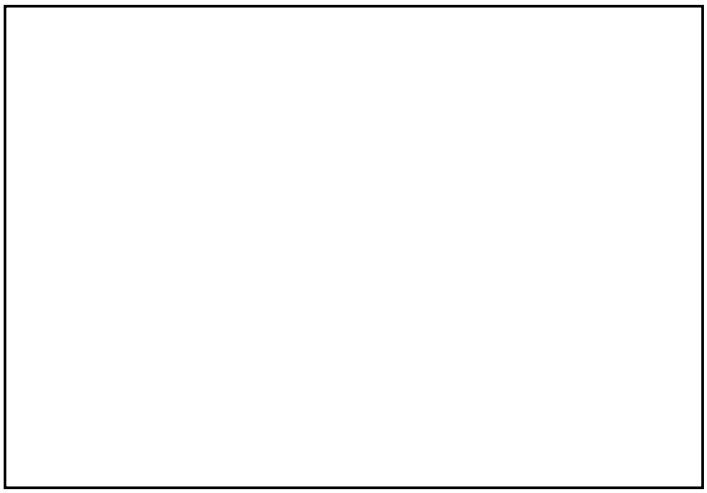

Figure 5. Children's Drawing of Playing with Friends and Surrounding Nature. (Reproduced from Ghanbari-Azarneir et al., "Identification of Child-Friendly Environments in Poor Neighborhoods.").

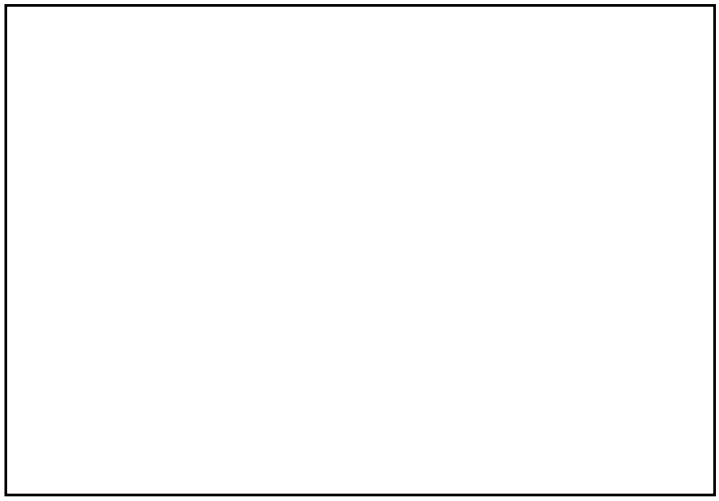

Figure 6. Children's Drawing of Preference of Space to Play. (Reproduced from Ghanbari-Azarneir et al., "Identification of Child-Friendly Environments in Poor Neighborhoods.").

The children from the Farahzad study also demonstrated concern about child-friendly play areas, for example, preference of floor material that is soft so as to avoid injuries.

Despite the fact that safety is a concern for them, children did communicate that they also like some risks, as they classified some attractive spaces as being “scary” and “exciting” as hiding places. See Figure 7. All psychologists that participated in the research believe that the use of the colors on drawings was related to children’s innate preferences for colorful play spaces. Noteworthy, too, is that 5 of the 40 children stated that they would choose to paint their play areas by themselves.

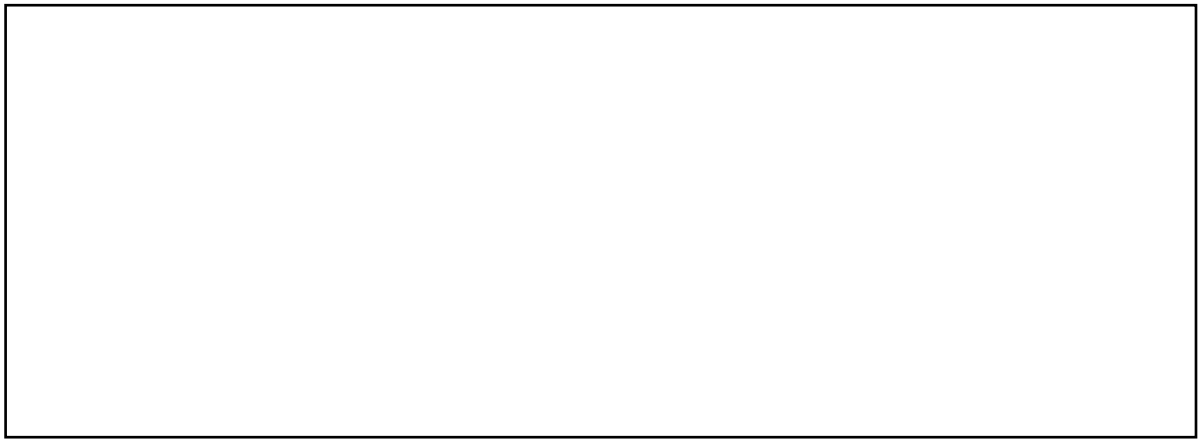

Figure 7. Children Playing in Alleys. (Reproduced from Ghanbari-Azarneir et al., "Identification of Child-Friendly Environments in Poor Neighborhoods.").

Information obtained through the Farrahzad study suggests that child-friendly spaces, with a high potential of being attractive for children to play, are outdoor spaces nearby home and school that include natural elements and that offer features that fosters excitement. The authors considered that designing for a poor neighborhood does not necessitate the inclusion of traditional play equipment like swings and slides because children have a fertile imagination allowing them to simply play in the environment that surrounds them.

Mary Ann Kirkby is a Canadian author and journalist who has written two memoirs about her childhood in the Hutterite tradition. In her 1989 study, "Nature as Refuge in Children's Environments," she questioned children’s preferences regarding spaces in which to play and she found that children were more attracted to natural settings than a "less complex" built

environment most typically found within contemporary playground structures.[63] Essentially, understanding children's outdoor play preferences and physical, psychological, and emotional needs, is essential for the design of innovative playground spaces that are more attractive and beneficial for child development so as to investigate children's behavior and preferences regarding spaces in which to play, refuges, and places to hide were identified as highly attractive for children.[64] In this study, 79 preschool-aged children from Seattle, Washington, were observed within a playground with natural and built equipment with three different hiding-places—what the author called "refuges" See Figure 8.

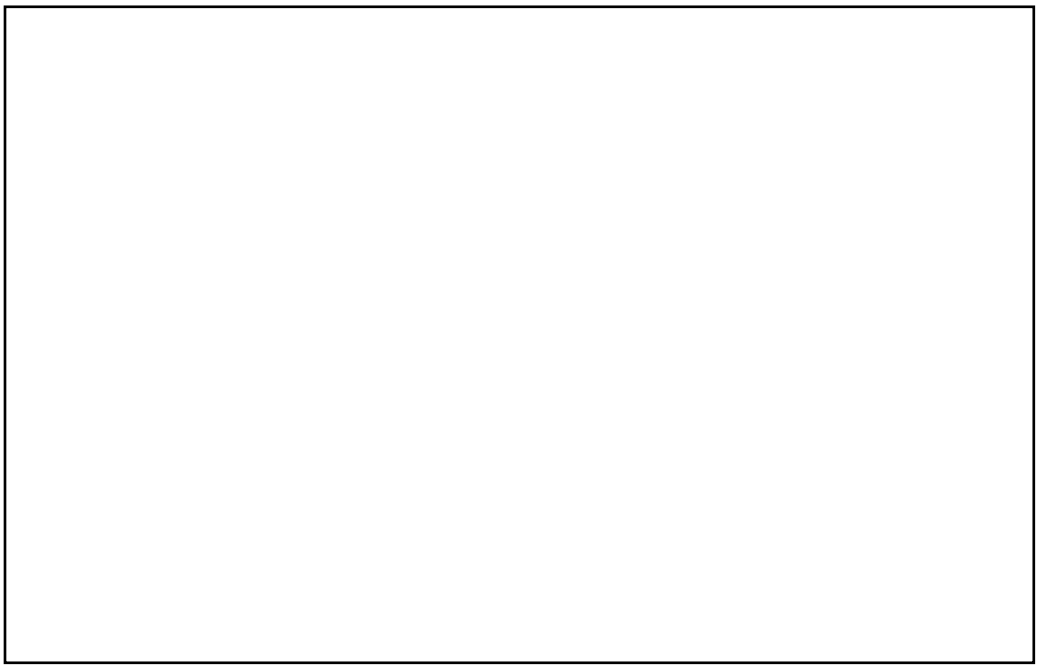

Figure 8. Plan for playground showing refuge areas and other play equipment. (Reproduced from Kirkby, "Nature as Refuge in Children's Environments.").

The playground area consisted of an open grassy field with approximately 10% of built and natural refuge type of areas. The three refuge settings offer enclosure and seclusion settings.

[63] Mary Ann Kirkby, "Nature as Refuge in Children's Environments," *Children's Environments Quarterly* 6, no. 1 (1989): 7–12.
[64] Ibid.

Refuge 1 and Refuge 2 were formed in the two corners of the playground that have more of a dense vegetation, and the Built Refuge was designed with two decks connected by a bridge. The Kirkby study was divided into two phases—one that identifies settings preference and other to identify play behavior. She determined that 47% of use occurred in one of these enclosed areas (23% in the Built Refuge and 24% in natural Refuge 1 or 2). These three refuge areas account for approximately 10% of the total area of the playground. A variety of play behavior was identified within the three refuge settings, and design guidelines were suggested for creating spaces that are attractive to children. For example, children prefer enclosed types of spaces that increase a sense of refuge and manipulable parts offering more creative play. In addition, enclosed spaces with multiple entrances and exits could be included in design so as to allow visual connection to the overall surroundings and to provide a sense of privacy and safety. Preference for the natural refuges was observed, throughout the Kirkby study. Thus, the study concluded that children prefer to play in spaces that provide areas of refuge—both natural and built—instead of traditional contemporary playground equipment.

Even though the Kirkby study and the Sharareh Ghanbari-Azarneir et al. study were conducted in uniquely contrasting settings informed by specific methodologies and twenty-sixty years apart, the results were largely analogous. In both cases, one finds similarities in children's preference for natural spaces, and some similar characteristics of children's play behavior that define an attractiveness of the space. However, do children prefer natural spaces instead of built playgrounds?

According to Tina M. Bourke, a graduate student in the Department of Psychology at the University of Waikato, and Rebecca J. Sargisson, a Senior Lecturer of Psychology at the University of Waikato in New Zealand, in an article called "A Behavioral Investigation of Preference in a New Zealand Playground," declares that children like equipment that allows them to take certain risks like spinning, climbing, and swinging, all at different speeds, and the ability to

be high above the ground at various levels.[65] Knowing children's preference for natural spaces and for playground equipment that includes possible risk-taking is key for designing spaces that are attractive and engaging but, at the same time, are safe for all who play there.

To better understand children's preference for play on either a built or a natural environment, an observational study called "Children's Use of Nature in New Zealand Playgrounds" was conducted by Rebecca J. Sargisson, a Senior Lecturer of Psychology at the University of Waikato in New Zealand, and Ian G. McLean, a PhD from Biological Psychology, Behavioral Science and Evolutionary Biology from University of Alberta, Canada.[66] Children's behavior was observed in 56 different playgrounds, all of which offer both natural and built play equipment settings. See Figure 9.

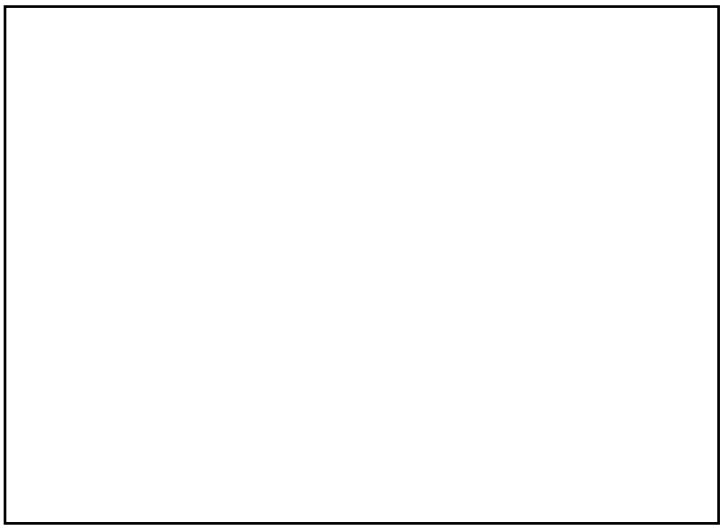

Figure 9. Playground in Thames built around a large tree that children were observed climbing. (Reproduced from Rebecca and Ian, "Children's Use of Nature in New Zealand Playgrounds.").

[65] Tina M. Bourke and Rebecca J. Sargisson, "A Behavioral Investigation of Preference in a Newly Designed New Zealand Playground," *American Journal of Play* 6, no. 3 (2014): 370–91, http://www.journalofplay.org/sites/www.journalofplay.org/files/pdf-articles/6-3-article-a-behavioral-investigation-of-preference.pdf.

[66] Rebecca J. Sargisson Rebecca and Ian G. Mclean, "Children's Use of Nature in New Zealand Playgrounds," *Children, Youth and Environments* 22, no. 2 (2012): 144–63, http://www.jstor.org/stable/10.7721/chilyoutenvi.22.2.0144.

The results showed that, overall, only 14 percent of children's playtime was spent on or with natural elements rather than non-natural elements. However, not all of the playgrounds within the study group had the same natural elements. That being said, the authors identified a meaningful association between the amount of diversity throughout the natural elements within a given playground and the percentage of the time that children spent playing there versus playing on the built structures within the respective playgrounds. They observed that children spent more time playing within natural elements when there was a greater diversity of it. The authors concluded that the lack of interest in natural elements over the built equipment was due to the scarce diversity of nature. The authors suggested that a variety of natural elements that allow diversified opportunities for play will be more attractive for children than built equipment.

2.2 Playground Safety

The first publication of playgrounds appears as an illustration by Henry Barnett in 1848. See Figure 10.

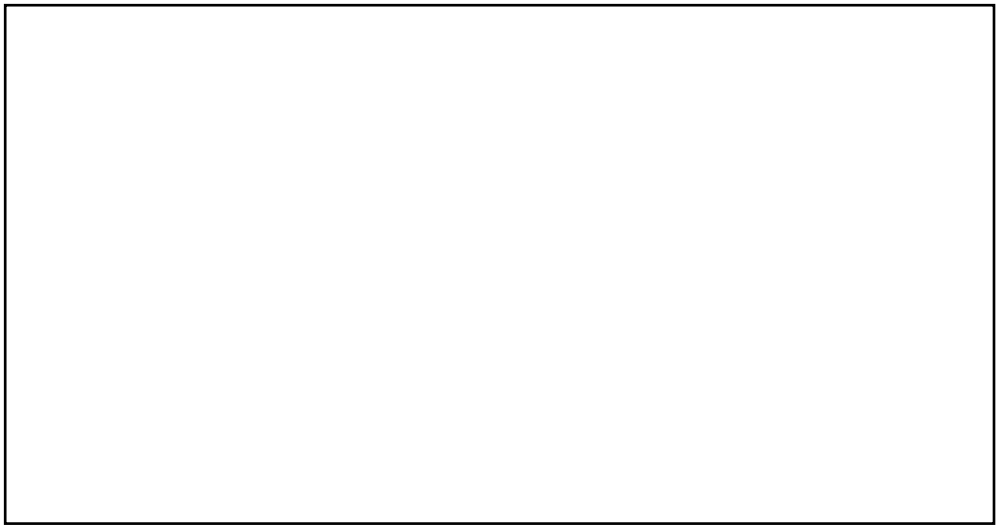

Figure 10. Nineteenth-century view of a playground for young children. Image from H. Bernard 1848, courtesy of University of Michigan, Making America. (Reproduced from Moore, "Playgrounds").

The idea of playgrounds as a pedagogical space for children originated in Germany and then extended to American schools by the end of the nineteenth century.[67] It was when the theories of psychologists such as those of Jean Piaget, a Swiss clinical psychologist known for his pioneering work in child development, began to address the importance of play for children's overall development that changes began to be made regarding playground design.[68]

It was in the early 1900s that playgrounds started to find their way into the city. Founded in 1906, The Playground Association of America, later the National Recreation and Park Association, brought the concept of playground design to a municipal realm with an intentional creation safety-base spaces for socializing and for physical activity for children living in municipal spaces. According to Amy Ogata, a PhD of Art and Archaeology from Princeton University and an author of "Designing the Creative Child: Playthings and Places in Midcentury America "the early twentieth-century playgrounds in America were primarily designed for the socialization of immigrants who lived in poor neighborhoods.[69] See Figure 11.

[67] Robin Moore, "Playgrounds: A 150-Year-Old Model," in *Safe and Healthy School Environments,* ed. Howard Frumkin (Oxford, UK: Oxford University Press, 2006): 86–103.
[68] Ibid.
[69] Amy Ogata, "American Playgrounds: Revitalizing Community Space," *Design Issues* 26, no. 2 (Spring 2010): 82–3, https://doi.org/10.1162/DESI_r_00008.

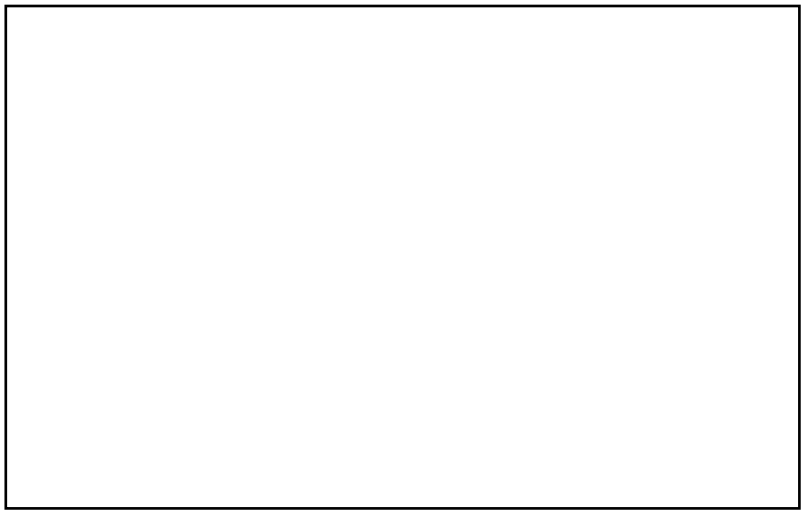

Figure 11. Perkins Square Playground, early twentieth century. (Reproduced from AkronOhioMoms, http://www.akronohiomoms.com/ohio/akron-area-landmarks-yesteryear).

These playgrounds were basically composed of swings, seesaws, and a sandbox installed on a hard surface. Although safety principles existed as primary criteria within the design of these early playgrounds, several injuries were reported which was responsible for some design modification.[70]

Increased excitement about the design of the playgrounds occurred when world-renowned architects and designers became involved with their design. In 1933, a famed sculptor Isamu Noguchi designed his first playground for America. Noguchi (1904–1988) was born in United States and was raised in Japan, from where he gained influence regarding his design. He called his first playground "Play Mountain," and he considered it to be the "progenitor of playgrounds as sculptural landscapes."[71] The design of Play Mountain resembled a molded earth, and it included natural elements such as rocks and water. In addition, the design included steps and a ramp that allowed children to slide down a slope and into the water. See Figure 12. Despite the innovation, Noguchi's landform of design was rejected by the New York Parks Commissioner Robert Moses,

[70] Solomon, *American Playgrounds*, 8.
[71] Solomon, *American Playgrounds*, 10.

and the Play Mountain was never built. However, this bureaucratic barrier did not prevent Noguchi's future attempts to design playgrounds.

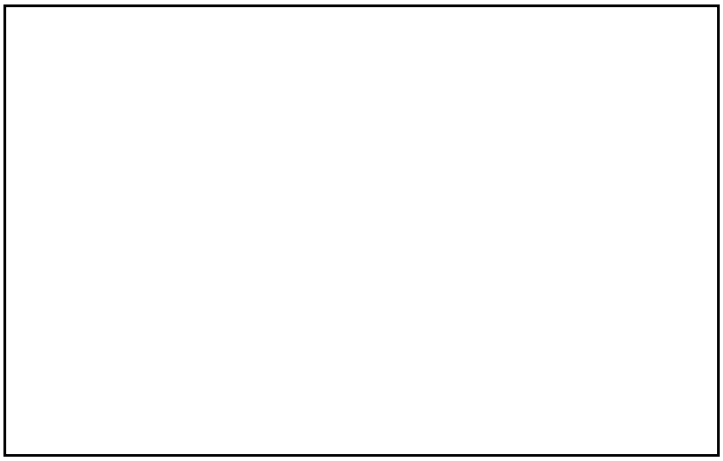

Figure 12. Isamu Noguchi, Model of Play Mountain, 1933. Plaster. Unrealized. (Reproduced from Solomon, American Playgrounds).

In 1935, Noguchi embraced another innovative approach and designed sculptural playground equipment for Ala Moana Park on Oahu, within the Hawaiian Islands, but the commission of this playground was also rejected by the Park Department due to safety concerns. See Figure 13.

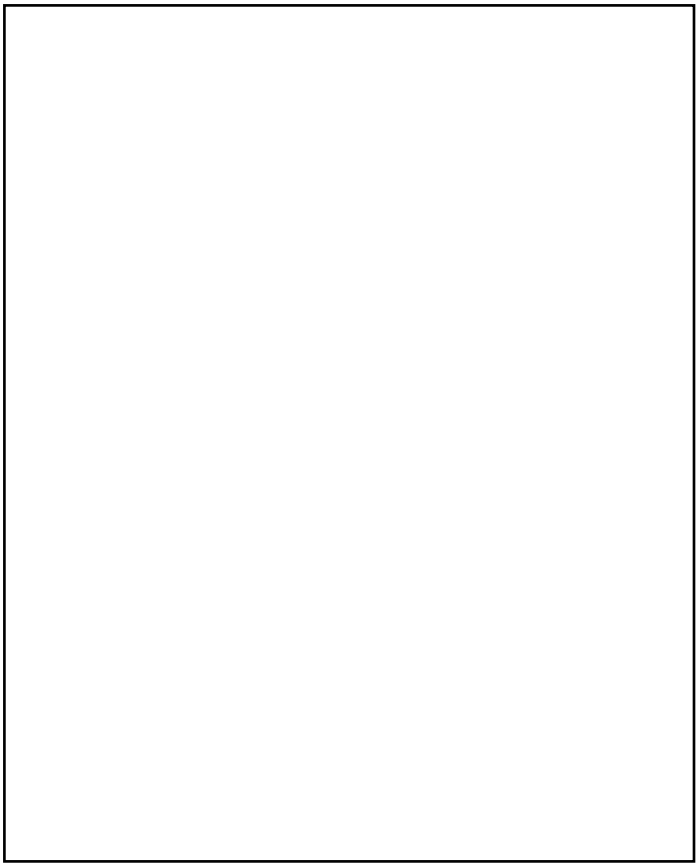

Figure 13. Model of Playground for Ala Moana Park, Hawaii, 1935. (Reproduced from Larrivee, "Playscapes," 53–80).

Noguchi tried to introduce his ideas to New York City, but they were also rejected by the New York Parks and Commissioner. In 1941, after being criticized that his stepped swings and seesaws were too dangerous, he tried different approaches. He designed Contoured Playground for New York —an entirely of earth mounded, channeled, and hollowed, excavated and elevated landscape, based on previous ideas from Plain Mountain. See Figure 14.

However, during World War II, Noguchi went to Japan to voluntarily work in a detention camp for Japanese Americans, and the Contoured Playground was also never built.

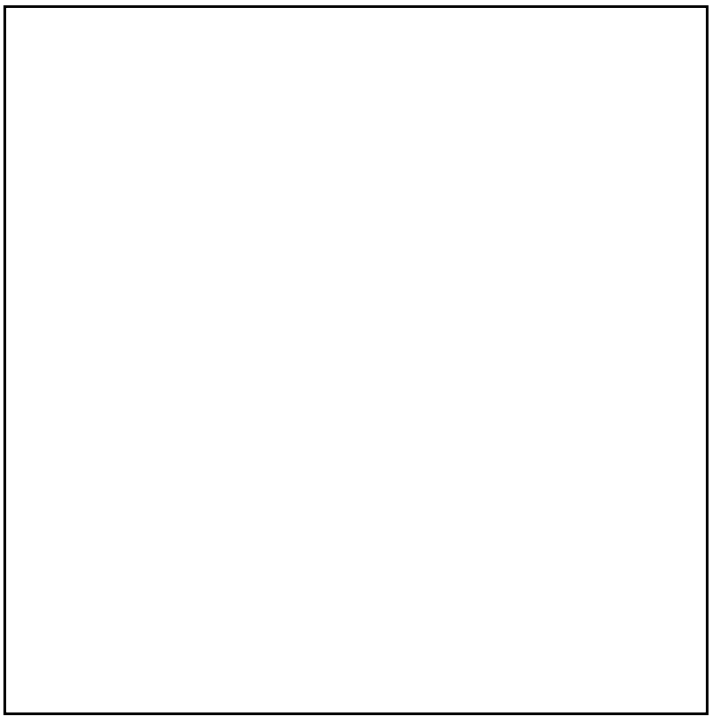

Figure 14. Isamu Noguchi. Model for Contoured Playground. 1941. Bronze cast from plaster original. (Reproduced from Larrivee, "Playscapes," 53–80).

In 1948, American administrators and recreation planners were interested in built playgrounds that also created opportunities to integrate schoolyards and parks to provide opportunities for physical activity. After this time, playgrounds began to be seen as opportunities to insert art, and Noguchi had a major commission to design a playground. From 1950 to 1960, Noguchi tried again, unsuccessfully, to implement his ideas to build a playground in New York. In 1951, together with American architect and planner Julian Whittlesey, he designed a playground for the United Nations that was inspired by the 1941 Contoured Playground. It consisted of a series of abstract shapes and customized equipment that was also rejected by Parks Commissioner Moses and United Nations. However, the Museum of Modern Art promoted an exhibition with a plaster model of this playground to give it more visibility and call attention to the fact that a playground as a sculpture exists as an opportunity to create a more stimulating space for children.[72] Two years later, this playground was included in a journal as a new trend of "Sculptural Play Forms." In 1961, Noguchi invited Louis Kahn to participate in the design of the Levy

[72] Solomon, *American Playgrounds*, 25.

Memorial Playground in the Manhattan's Riverside Park. See Figure 15. This project went through many modifications, but it was abandoned in 1966. Kahn and Noguchi worked together for five years with a variety of proposals, all of which were rejected because of aesthetic, political, and safety concerns.[73] Even though Noguchi and Kahn's playgrounds were never built, they left behind a legacy of a design that later inspired architect Richard Dattner and landscape architect M. Paul Friedberg regarding their playground designs.[74]

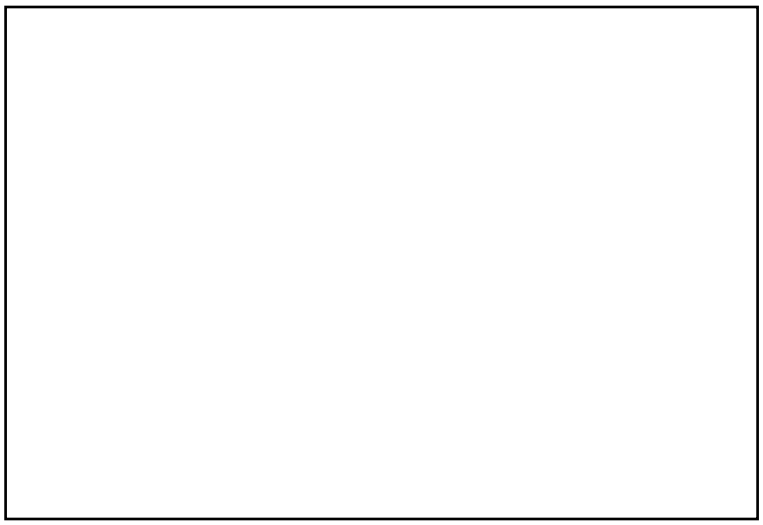

Figure 15. Isamu Noguchi and Louis Kahn, Levi Memorial Playground 1961–1966, Final Version (Reproduced from Larrivee, "Playscapes," 53–80).

In Europe, a Dutch architect Aldo van Eyck had been positively influencing an entire generation of children through his design of playgrounds in the city of Amsterdam.[75] First recognized for his building design, van Eyck embraced the creation of public playgrounds. Although these playgrounds were inserted in arid spaces without considering the integration with nature, they had the ability to transforming underutilized interstitial spaces into places for children to play and for parents' socialization. Aldo van Eyck was the innovator regarding integrating playgrounds into the

[73] Ibid, 53.
[74] Ibid, 54.
[75] Anja Novak, Debbie Wilken, and Liane Lefaivre, ed. Ingeborg de Roode, *Aldo Van Eyck: The Playgrounds and the City* (Amsterdam, NL: NAi Publishers, 2002), 8.

interstitial spaces within the urban fabric of a city like Amsterdam. Between 1947 and 1978, he would design and build more than 700 playgrounds for the Amsterdam Public Works Department. See Figure 16.

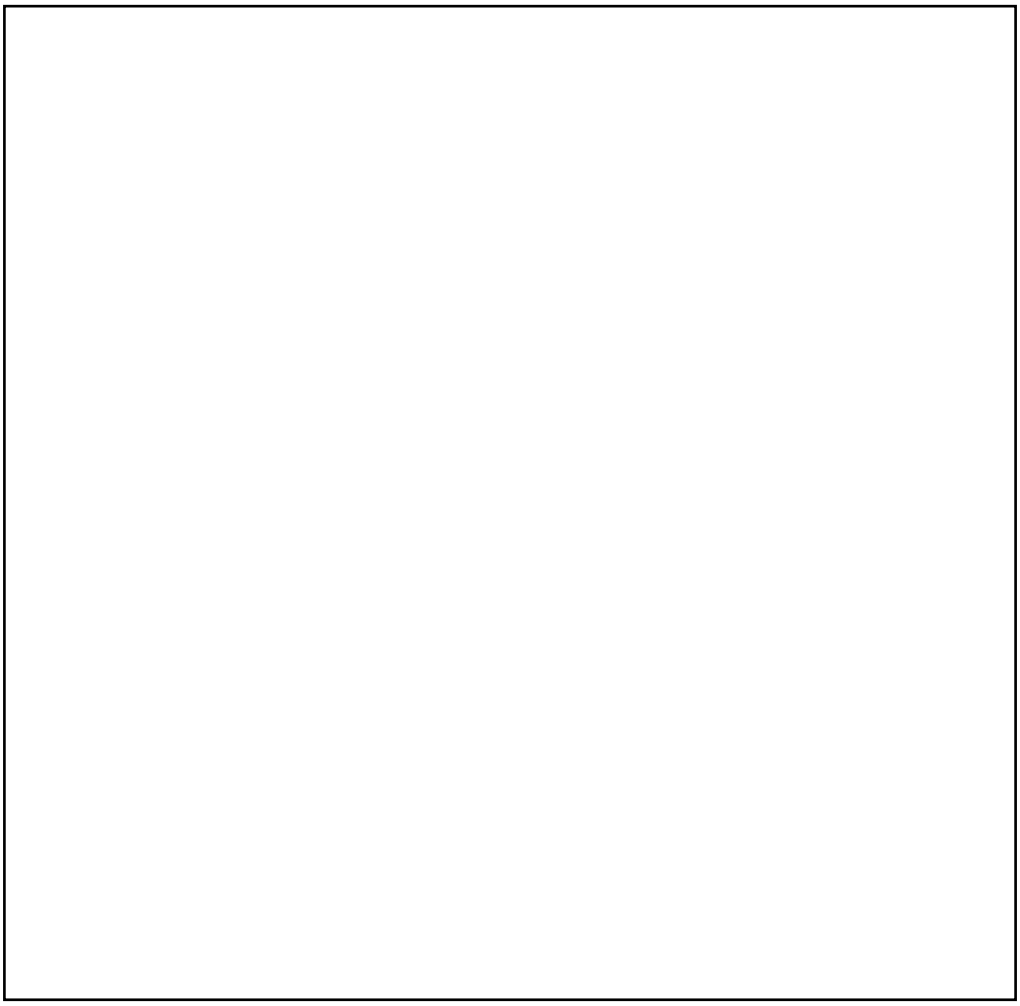

Figure 16. Dijkstraat Amsterdam–Centrum, 1954. (Reproduced from Novak, *Aldo van Eyck*).

After World War II, the implementation of these playgrounds represented the change of an era. The traditional “top-down” style approach defined by Congrès Internationaux d'Architecture Moderne (CIAM) to modernist urbanization was giving way to spaces designed with a “ground-up”

approach in which interstitial spaces provided a unique opportunity for the city.[76] Because of the natural irregularity of the interstitial spaces in an urban fabric, the design of van Eyck playgrounds ended up being aesthetically asymmetrical and irregular, which made them unique.[77] This exclusive aesthetic of the van Eyck playgrounds was defined by Liane Lefaivre, a professor and chair of Architectural History and Theory at the University of Applied Arts in Vienna Austria, as simultaneously sculptural and urbanist elements that "gives a frame to urban life."[78] See Figure 17.

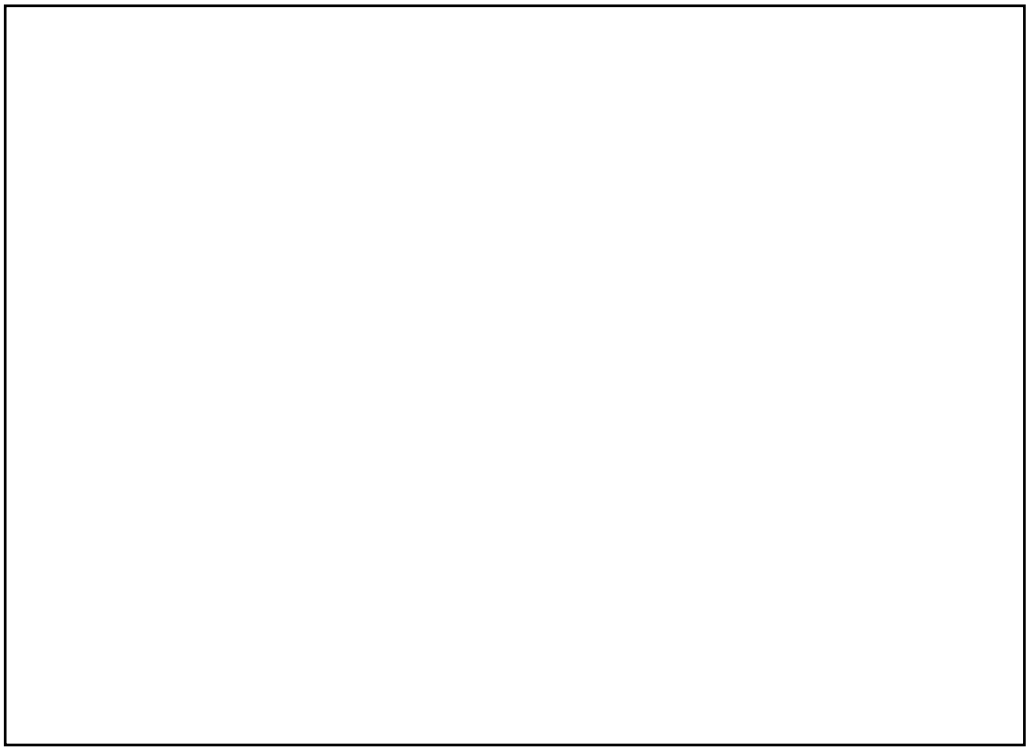

Figure 17. Laurierstraat Amsterdam–Centrum (Reproduced from Novak, *Aldo van Eyck*).

His playgrounds began to be constructed throughout the city of Amsterdam along with throughout its street corners, in vacant plots, in courtyards, and in public gardens and suburbs. Van Eyck

[76] Novak, et al., *Aldo Van Eyck*, 16 –57.
[77] Ibid.
[78] Ibid.

believed that was a “pity” that cars took spaces in a city that could be useful for children. See Figure 18 and Figure 19.

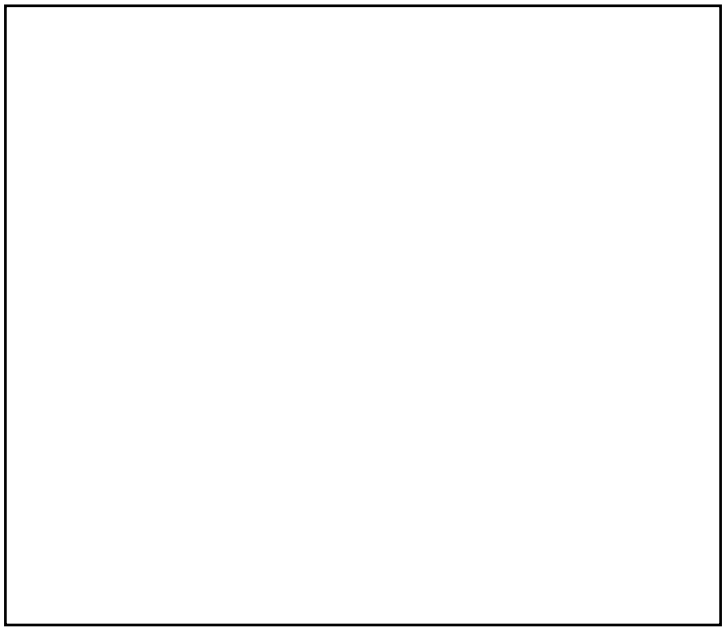

Figure 18. Laurierstraat, Amsterdam–Centrum. (Reproduced from Novak, *Aldo van Eyck).*

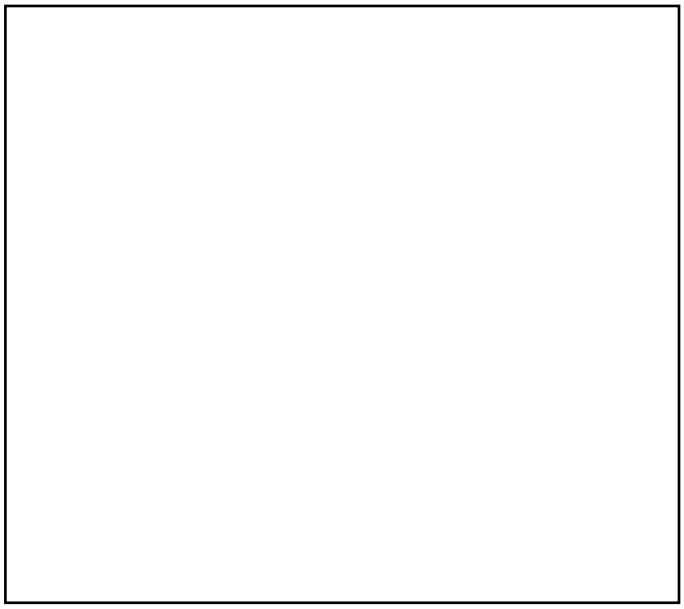

Figure 19. Laurierstraat, Amsterdam–Centrum (Reproduced from Novak, *Aldo van Eyck).*

The playgrounds were designed to stimulate a child's imagination, and, as such, they allowed children to make a variety of free and even acrobatic movements through climbing, swinging, and jumping. See Figure 20. The playgrounds generally consisted of two distinct elements—metal-framed structures and concrete.

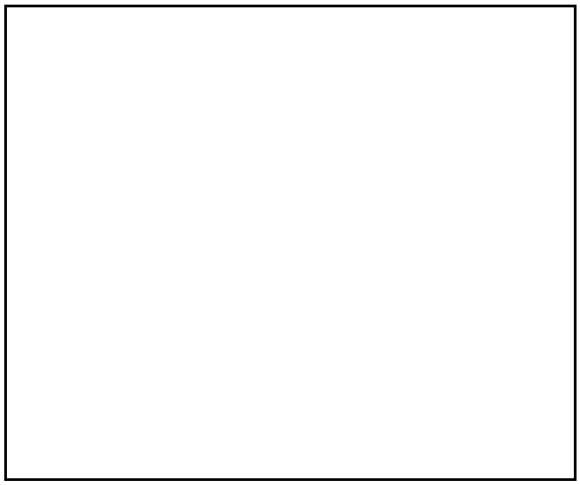

Figure 20. Laurierstraat, Amsterdam–Centrum. (Reproduced from Novak, *Aldo van Eyck).*

Aldo van Eyck playground's design was inspired by the art movement entitled Cobra. The name was coined by Christian Dotremont from the initials of the members' home cities, which were Copenhagen (Co), Brussels (Br), Amsterdam (A). The COBRA movement was an avant-garde movement occurring in Europe between 1948 and 1951 and had child-related themes as a basis for inspiration. See Figure 21.

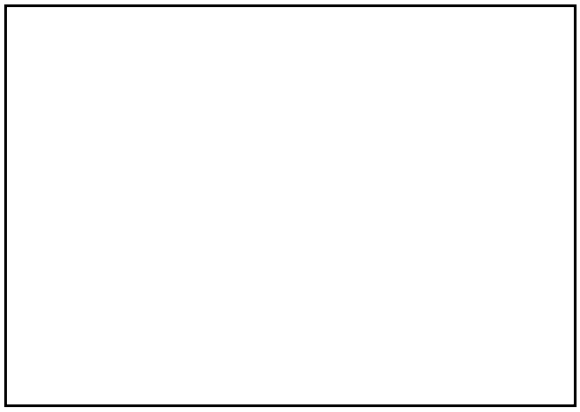

Figure 21. Aldo van Eyck playground and Christiaan Karel Appel. (Reproduced from Novak, *Aldo van Eyck).*

Aldo van Eyck saw in every available space an opportunity to implement a playground. Each playground designed by van Eyck was site-specific, and each had its own exclusive configuration where the layout was adapted to the site where it was inserted. See Figure 22. Van Eyck playgrounds were inserted using the same material as the nearby streets and sidewalks to reinforce the connection with an urban context. Without a fence, the perimeter of the playground was open to the city and was defined by the furniture (benches) or play elements.

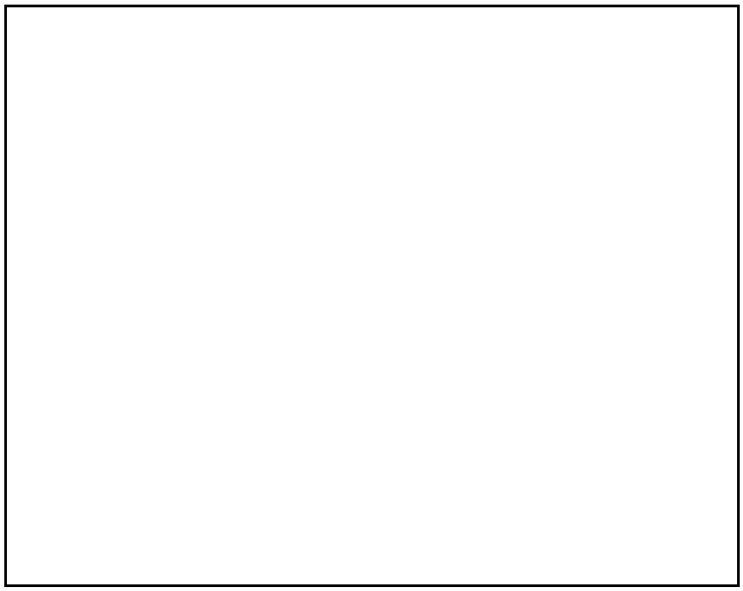

Figure 22. Examples of new designs for playgrounds introduced by van Eyck. (Reproduced from Novak, *Aldo van Eyck).*

Usually the place chosen for one of van Eyck's playgrounds was an interstitial space within the urban fabric of the city thus allowing the city itself to become more useful for its inhabitants thanks largely to the integration of Van Eyck's playgrounds. See Figure 23 and Figure 24.

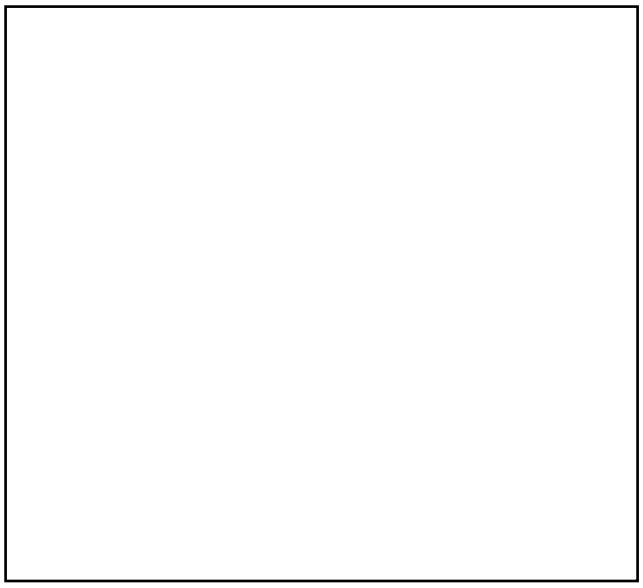

Figure 23. Interstitial spaces–Opportunities for the use of previously unused spaces between buildings. (Reproduced from Novak, *Aldo van Eyck).*

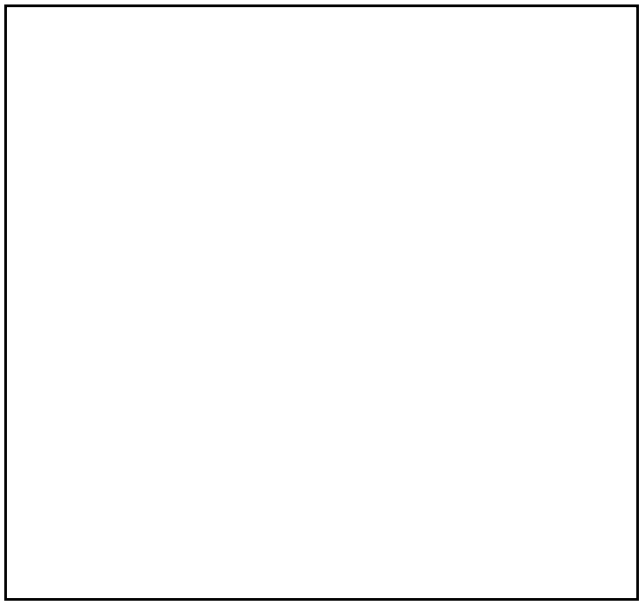

Figure 24. Interstitial spaces–Opportunities for the use of previously unused spaces between buildings. (Reproduced from Novak, *Aldo van Eyck).*

During their heyday, Aldo van Eyck's playgrounds existed as successful examples of how effectively integrating playgrounds into the urban fabric motivated children to go out to play and to happily become part of the urban setting. As of 2017, only a few of Aldo van Eyck playgrounds

had been renovated and currently exist intact, and most of them were replaced by contemporary playgrounds.

According to Lefaivre, the aesthetic appeal of the playgrounds had the intention of renovating urban spaces post-World War II, when safety issues did not exist as the primary impetus for design.[79] In the opinion of Susan Solomon, a Ph.D. and art historian from the University of Pennsylvania and author of "American Playgrounds Revitalizing Community Space," it was in the mid-1970s that "the situation took a wrong turn."[80] Solomon declares that "Risk Assessment," which was a slogan in the seventies, was largely responsible for the monotony within the design of the playgrounds. Solomon believes that some designers, architects, and landscapers, once enthusiasts in designing playgrounds, often refused this commitment fearing safety-based legal issues, and playground design started to become somewhat monotonous so as to maintain safe equipment for children's outdoor play.[81]

With an innovative approach came Adventure Playgrounds. The first Adventure Playgrounds were designed in 1943 by a Danish landscape architect Carl Theodor Sorensen from Emdrup, Denmark.[82] These playgrounds, also called "junk playgrounds," were not necessarily seen as "aesthetically pleasing" by adults.[83] However, these playgrounds were very attractive to children and comprised areas where they could freely play with items they found there that were quite different from their usual toys—tools, discarded pieces of wood and nails, pieces of metal, and chunks of stone. See Figure 25.

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[79] Novak, et al., *Aldo Van Eyck*, 16–57.
[80] Solomon, *American Playgrounds*, 43.
[81] Ibid.
[82] Solomon, *American Playgrounds*, 78.
[83] Ibid.

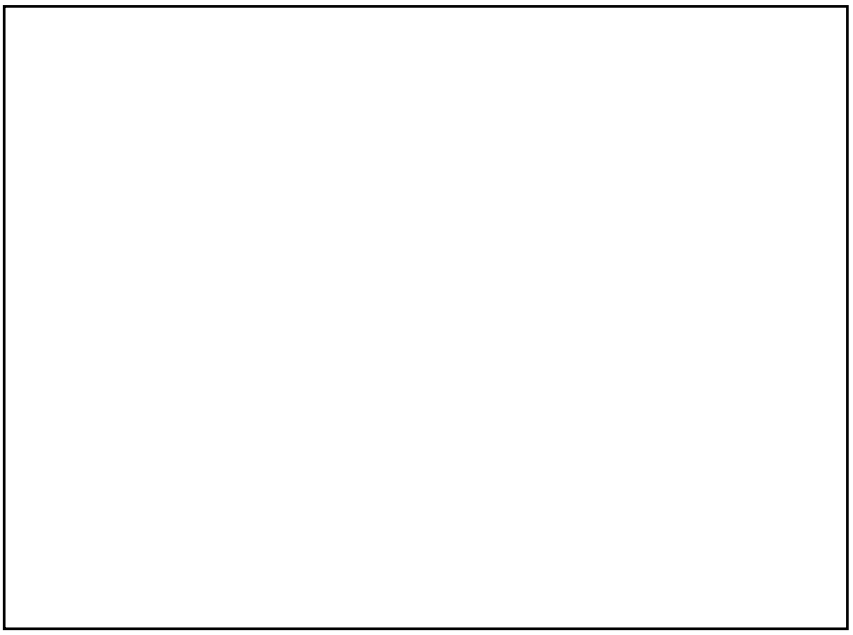

Figure 25. Adventurous Playground Emdrup 1945. (Reproduced from Bengtsson, *Adventure Playgrounds*).

In the words of British landscape architect Lady Allen of Hurtwood, who was a trained horticulturist and a founder of the World Organization for early Childhood Education, playgrounds from the seventies were “an administrator’s heaven and a child’s hell.”[84] Lady Allen was responsible for introducing the concept of Adventure Playgrounds to Great Britain in 1950. She argued that playgrounds were safe spaces for children to play but not very interesting for them. Lady Allen was an advocate for the nurturing and overall health of children, and she was a great promoter of Adventure Playgrounds throughout Great Britain. She defended the idea that the only spaces in which children could truly find freedom and express self-determination and self-expression was on such playgrounds that fostered a sense of adventure.[85] In Lady Allen words, “Adventure Playgrounds” exist as spaces that encourage imaginative interaction and exploration with natural elements incorporated within respective playground design and based on psychology

[84] Solomon, *American Playgrounds*, 78
[85] Maisie Rowe, “The New Adventures of the Adventure Playground,” *The Spectator*, July 25, 2015, http://www.spectator.co.uk/2015/07/the-new-adventures-of-the-adventure-playground.

theories from Jean Piaget and Erik Erikson's.[86] According to the analyses of Solomon, what largely made these playgrounds so attractive for children was the "illusion of danger."[87] Children were allowed to play with materials and tools that were usually reserved for adults.

By the middle of the 1960s in America, architect Richard Dattner and landscape architect M. Paul Friedberg were the pioneers in the design adventure playgrounds within the city of New York. Despite the fact that they worked independently, Dattner and Friedberg had been influenced by Noguchi's landforms of design. Dattner's Adventure Playground was renovated in 2001. It is located in Central Park and remains a favorite playground space for New York residents. See Figure 26 and Figure 27. It is also a space that includes various natural formations and shapes and manmade structures like tree forts, raised mounds, and tunnels, along with natural elements like sand and water. However, Adventure Playgrounds designed by Dattner and Friedberg differ from those in Europe, which utilized more scrap-based and found elements.

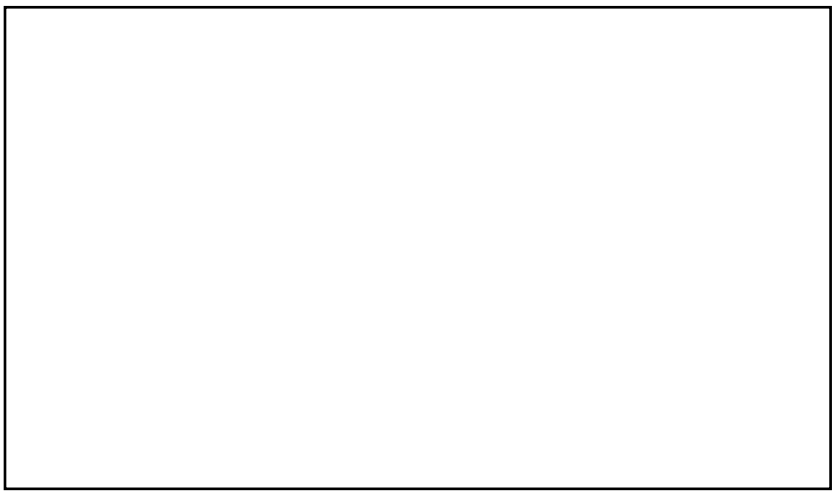

Figure 26 Richard Dattner rehabilitated Adventure Playground 2015 (Reproduced from http://www.centralparknyc.org/about/restoration.html)

[86] Solomon, *American Playgrounds*, 12.
[87] Solomon, *American Playgrounds*, 13.

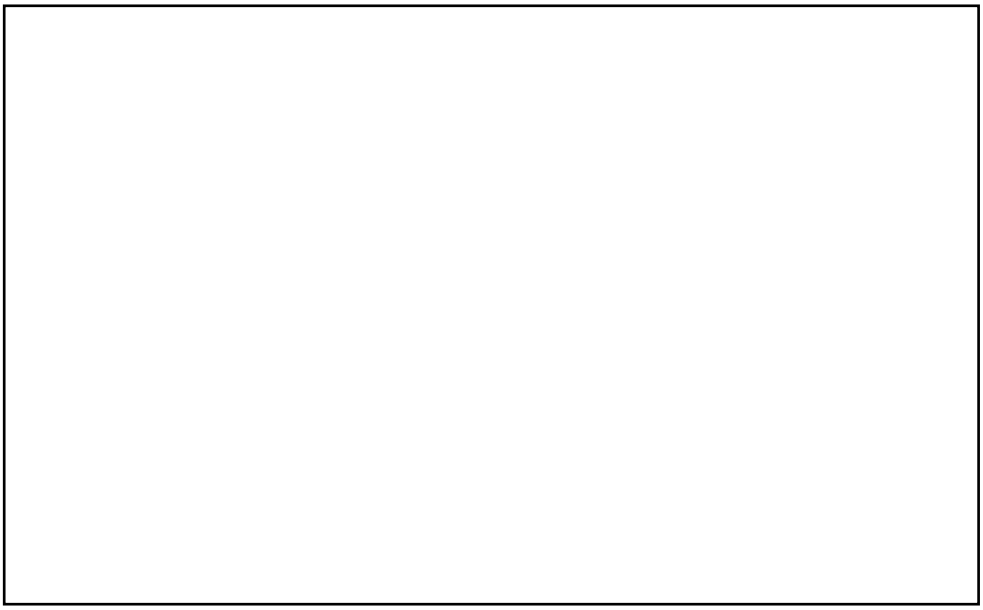

Figure 27. Richard Dattner Adventure Playground N.Y. (Reproduced from http://www.dattner.com/portfolio/playgrounds/).

According to Solomon, Dattner and Friedberg were both aware of Piaget's theory about children's play and learning.[88] The Piaget's theory was reflected in a book that Dattner wrote and was published in 1969 called "Design for Play," which reflects the philosophy of play and developmental psychology. In 1979, Friedberg wrote "Play and Interplay: A Manifesto from New Design in Urban Recreational Development." Solomon argues that their respective work reflects their knowledge in studies that demonstrate children's preference for play with natural elements like sand and water rather than with fabricated play equipment. See Figure 28.

[88] Solomon, *American Playgrounds*, 55.

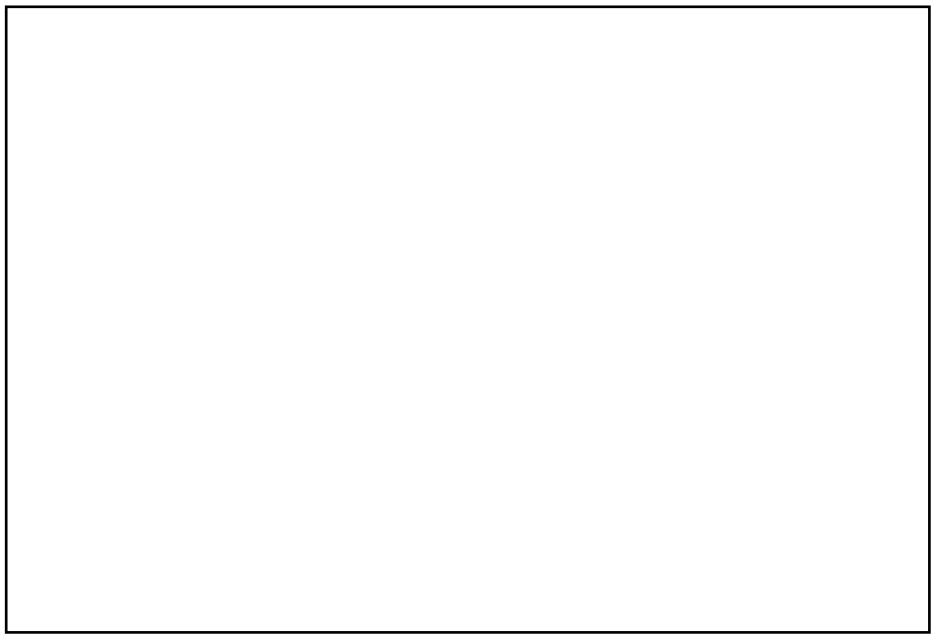

Figure 28. M. Paul Friedberg & Associates view of playground at Jacob Riis House, New York City. (Reproduced from Solomon, *American Playgrounds*).

According to Amy Ogata, an Art History faculty of University of Southern California, “Playgrounds today are one of the most overlooked and unappreciated spaces of contemporary design.”[89] A similar opinion was expressed by Solomon who states, “American playgrounds today are a disaster.”[90] With some exception, when one considers the majority of public playgrounds today, it seems that designers have taken one step back in comparison with playgrounds that were designed on the past. The concepts and theories of play that had been applied within the design of playgrounds since the 1970s, and the importance of these theories regarding children’s overall development are no longer applied within the design of the majority of playgrounds in the U.S. today. In addition, the primarily social aspect of playgrounds was forgotten in America during the postwar period.[91] Solomon criticizes the way American public playgrounds are designed and advocates that designers reconsider the use and aesthetics of the playgrounds declaring that the

[89] Amy Ogata, "American Playgrounds: Revitalizing Community Space," *Design Issues* 26, no. 2 (Spring 2010): 82–3, https://doi.org/10.1162/DESI_r_00008.
[90] Solomon, *American Playgrounds*, 1.
[91] Solomon, *American Playgrounds*, 1.

primary driver for the design of the playgrounds today is safety—not exploration and fun. She states that safety issues became the guidelines for all commercial products, and, consequently, the playground experience was also diminished.[92]

Similarly, Robin Moore, who holds degrees in architecture from London University and Urban Planning from Massachusetts Institute of Technology (MIT) and for most of his career has worked in the field of landscape architecture as an educator, a researcher, and a consultant, declares that most American public playgrounds today are predictable and static play structures made out of plastic and metal and are placed in isolated areas of greenspace.[93] Moore states that these colorful structures seem inviting, but they often become unappealing spaces for children because they actually limit their play. See Figure 29.

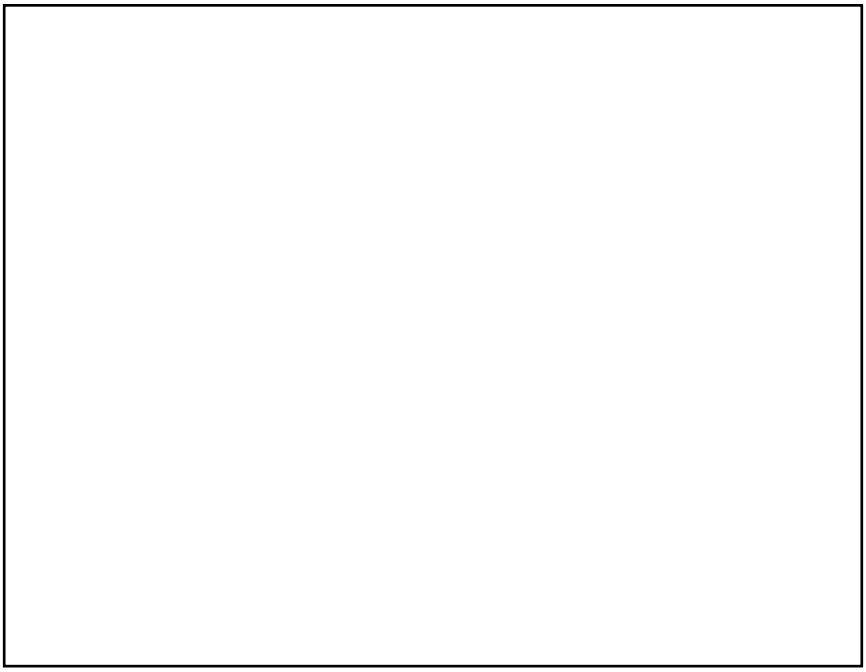

Figure 29. Playground in New Jersey. (Reproduced from https://magazine.funnewjersey.com/a-ranking-of-the-top-ten-playgrounds-in-new-jersey).

[92] Ibid.
[93] Moore, *Playgrounds*, 86–103.

Moore states that the playground environment has to be designed to urge children to take risk, as it is part of their development and is how they learn.[94] Moore continues that playgrounds should be also designed to promote spaces for parents and caregivers to comfortably watch their children play.

In his article “In Search of Peaceful Playgrounds,” John Evans, author of the Deakin University, recognizes the importance of playtime for children’s cognitive and social development.[95] He declares that playgrounds today are meant to be the safest places for children, but they often end up being uninviting, and children easily and quickly get bored with them. He proposes that, with contemporary playground design, children are overprotected from injury, and, as a consequence, they are deprived of experiences that would help with their cognitive and social development. Evans believes that children’s exposure to natural environments improves the quality of their playtime and, as such, allows for positive behavioral and social interaction. Thus, Evans advocates for designing play areas for children that include research-based design theories to create more interesting spaces in which children can play. However, as Solomon suggests, “There is reason for hope” and not all playgrounds are bad. The new playground area designed by Michael Van Valkenburgh (2003–2009) for Union Square North in New York City is an impressive exception. See Figure 30.

[94] Robin C. Moore, “Playgrounds at the Crossroads: Policy and Action Research Needed to Ensure a Viable Future for Public Playgrounds in the United States,” in *Public Places and Spaces (Human Behavior and Environment)*, eds. Irwin Altman and Ervin H. Zube (New York, NY: Springer, 1989) 83–121.
[95] John Evans, "In Search of Peaceful Playgrounds," *Education Research and Perspectives* 28, no. 1 (2001): 45–56, http://hdl.handle.net/10536/DRO/DU:30001066.

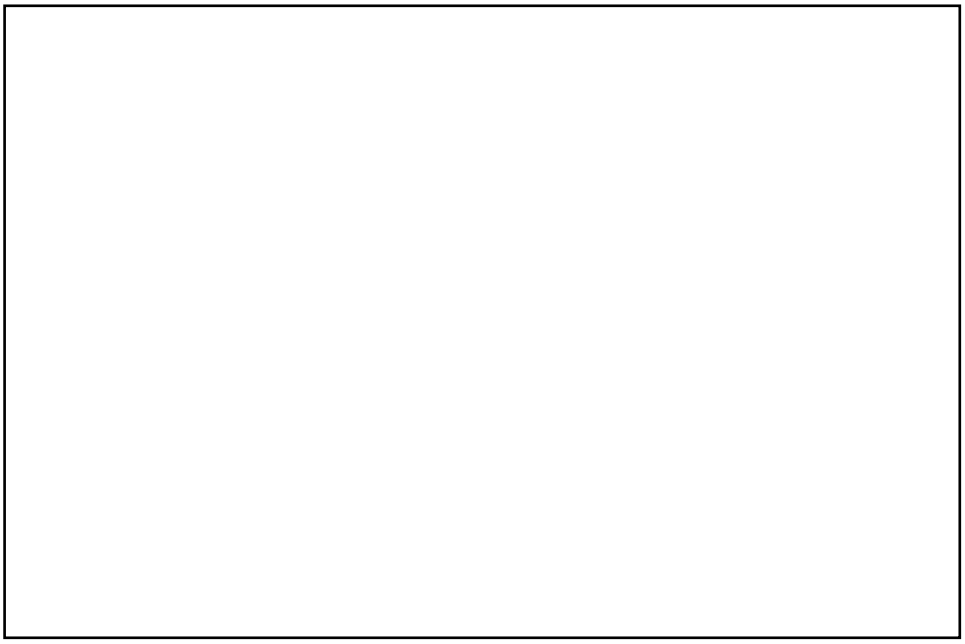

Figure 30. Union Square Park by Michael Van Valkenburgh, New York, NY. (Reproduced from https://www.nycgovparks.org/park-features/union-square-park/planyc).

The playground area exists as a combination of two small, age-differentiated playgrounds that offer swings and a sandbox, two slides, various other play structures, a spray shower, a large tunnel with another slide, and a climbing and sliding dome on the east side for older youth. For Van Valkenburgh, the most important concept within the design of his playgrounds is to "surround the children with a wrap of green space and tall trees."[96] The design integrates landscape within play areas and spaces for parents, thus providing attractive and inviting spaces for both children and adults. See Figure 31 and Figure 32.

[96] http://www.mvvainc.com/

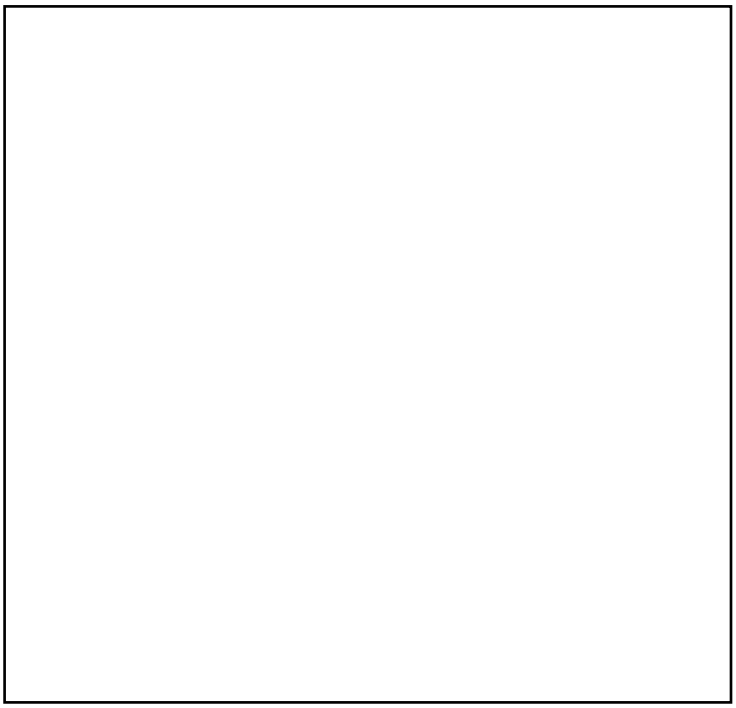

Figure 31. Union Square Park Michael Van Valkenburgh, New York, NY. Integration with Nature. (Reproduced from https://www.nycgovparks.org/park-features/union-square-park/planyc)

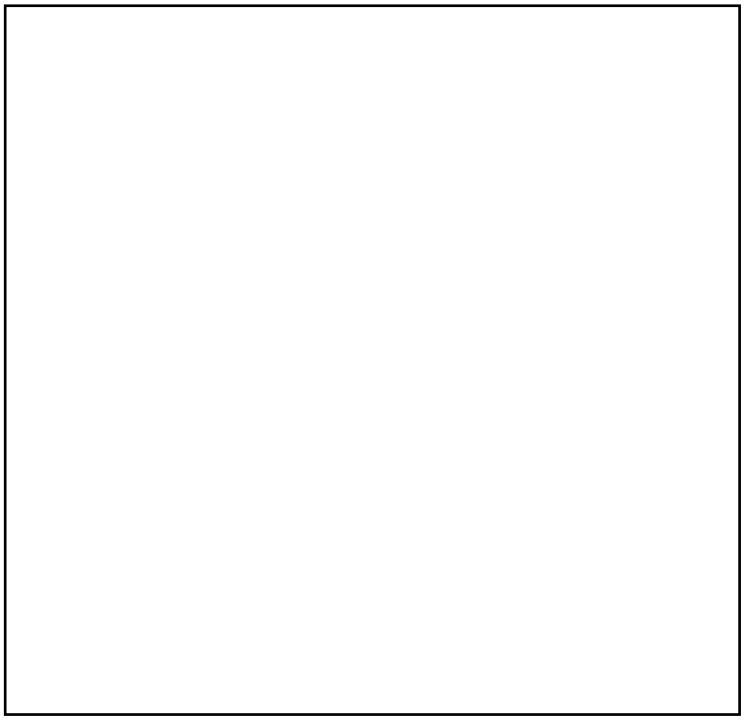

Figure 32. Union Square Park Michael Van Valkenburgh, New York, NY. Water Integrated on a Playground. (Reproduced from https://www.nycgovparks.org/park-features/union-square-park/planyc)

According to Solomon, American playgrounds today are "dominated by a McDonald's model'—a colorful and giant structure totally disconnected from any sort of natural landscape or setting and that does not contribute to the greater community, that limits social interaction, and that does nothing to stimulate children's respective individual learning processes.[97] Solomon expresses a particular regret regarding the absence of interesting playgrounds that could, quite easily, be "aesthetically noteworthy, educationally challenging and dangerously inspiring."[98] Echoing this statement, Jim Greenman, professor, author, and a senior vice-president for education and program development at Bright Horizons Family Solutions, states that, unfortunately, teachers and parents tend to prefer indoor play equipment instead of outdoor exploration[99] and that this kind of "sterile" environment does not offer the necessary stimulation and challenge for children's physical and social development.

The 1970s were marked by rising insurance costs and an excessive concern about safety in American playgrounds. These safety concerns, then, came to define how experiences of play were allowed to occur.[100]In the mid-seventies, the National Recreation and Park Association (NRPA) created guideline called the Proposed Safety Standard for Public Playground Equipment. Since 1991, the NPRA has sponsored the National Playground Safety Institute, which runs a course offering individuals the chance to graduate as a Certified Playground Safety Inspector. An individual with this certification, who is probably only concerned about safety laws, is the one who can conduct safety inspections and audits of playground equipment and has the authority to prevent the creation of a playground.

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[97] Solomon, *American Playgrounds*, 78.
[98] Ibid.
[99] Jim Greenman, *What Happened to the World?: Helping Children Cope in Turbulent Times* (Watertown, MA: Bright Horizons, 2001),11.
[100] Solomon, *American Playgrounds*, 78.

Playground safety is the primary concern within the design of playgrounds today. In 1981, the U.S. Consumer Product Safety Commission (CPSC), a federal regulatory agency, first published a Public Playground Safety Handbook, which consisted of safety design guidelines for both public and home playgrounds equipment. The handbook recommendations focus on how to avoid playgrounds-related injuries, being that the greatest concern is falls from equipment. Further recommendations in relation to the efficacy of the surface material, regarding it being impact absorbing, were made after the first edition and a focus was added to avoid hard surfaces (e.g. concrete, asphalt, or paved surfaces) and, instead, install soft surfaces (e.g. sand and wood mulch). The most recent version of the handbook was published in 2010 to comply with the American Society for Testing and Materials (ASTM) F1292—a voluntary standard for measuring impact attenuation of surfacing. In 1993, the ASTM defined a set of standards to be used on the product manufacturing of playgrounds, and all manufacturers are required by law to meet these standards. The CPSC handbook stands as guidelines, not a list of mandatory rules; however, some city and county jurisdictions may require compliance with this handbook and/or ASTM. The National Program for Playground Safety also defined a set of standards to be followed.[101] The International Play Equipment Manufacturers Association for Leisure and Recreation has its own guidelines.[102] States throughout the nation have begun to adopt some of these standards and guidelines; however, none of them have become regulated as federal law. Thus, to avoid liability, park commissions, schools boards, and, consequently, playground designers prefer equipment that meets the requirements so they are more protected against potential lawsuits.[103]

In 1990, The Americans with Disabilities Act (ADA) approved the only national-mandatory rule that prohibits discrimination based on disability and defined guidelines that should be provided to facilitate access to play equipment. According to the ADA, discrimination on the basis of disability

[101] "Standards," National Program for Playground Safety https://www.playgroundsafety.org/standards.
[102] https://ipema.org/
[103] Solomon, *American Playgrounds*, 80.

is prohibited by law.[104] In 2000, the U.S. Access Board published its official guidelines regarding play areas.[105] These guidelines were implemented as a law in 2010, and by March 15, 2011, all play areas throughout the entire U.S. were required to be in minimum compliance with these guidelines.

Taking an overview of the playground's history, especially within the U.S., one can see how the design has undergone modifications and how these designs tended to compromise the playground's primary purpose—an outdoor place to play in a way that allows for exploration, socialization, and fun. With some exception, most of the playgrounds in public spaces today in America are not the stimulating spaces for children that they are proposed or intended to be, nor are they spaces ideal for socialization as they once were.

According to the *generational theory*, ,described by authors William Strauss and Neil Howe in their book *Generations: The History of America's Future, 1584 to 2069*,[106] the degree of parental and societal protectiveness of children is cyclical and varying among generations and social, economic, and cultural views. Strauss and Howe were credited with coining the term *millennials* for a generation that has markedly shaped its characteristics through the use of and acquaintance with digital technology. Looking at the history of the playgrounds up until the present day, we can see cyclical changes in relation to security rules. What was once allowed within the design of playgrounds today is no longer possible. The excessive focus on the safety, responsible, among other things, for diminished playground design, likely led to an overall attraction to digital technologies that have likely kept children inside a home or school and far from playgrounds. By recognizing children's preference for natural spaces in which to play, the application of biophilic

[104] https://www.ada.gov/
[105] https://www.access-board.gov
[106] Neil Howe and William Strauss, *Generations: The History of America's Future, 1584 to 2069* (New York, NY: William Morrow & Company, 1992), 80.

design within playground design might exist as the ideal solution to creating more attractive play spaces for children.

As such, I propose that applying biophilic concepts to the design of playgrounds will allow for the creation of the ideal playground environment for children's overall development. However, since safety issues have become the primary driver and the major concern regarding the design of playgrounds today two primary questions exist. How exactly can biophilic design concepts be applied to playground and make them attractive and stimulating while still being safe for children's play? In addition, what are the spaces opportunities in dense urban areas for applying this type of architectural design?

2.3 Biophilic Design

Deriving from the biophilia hypothesis, the concept of biophilic design is "an approach that fosters beneficial contact between people and nature in modern buildings and landscapes."[107] An increasing body of research is revealing that this inherent tendency to affiliate with nature has influence on people's physical, psychological and emotional health.[108]

This attraction to nature and natural system has a biological origin from the time humans lived in a more natural and less constructed environments. It is believed that one's appreciation for nature is formed when a beneficial experience occurs during one's specific encounter with nature.[109] Biophilic design encourages the utilization of natural elements within a built environment. The main goal of biophilic design is to positively connect people with nature in a built environment; however, biophilic design will not solely benefit humans but the environment as a whole

[107] Stephen Kellert, Biophilic Design (Hoboken: John Wiley and Sons, Inc., 2008), 3.
[108] Stephen R. Kellert and Elizabeth F. Calabrese, *The Practice of Biophilic Design* (2015), 4.
[109] Kellert, *Building for Life*, 93.

system.[110] Applying biophilic design concepts within a built environment exists as an opportunity to provide positive contact with nature for human beings' overall wellbeing in that biophilic design can help to reduce stress, improve creativity and cognitive abilities, and accelerate healing.[111]

However, the following question stands. What are the most ideal biophilic design features for playgrounds, and how they can be applied within a built environment in a way that is attractive and beneficial to human beings, specifically children?

In 2005, Stephen Kellert, a professor emeritus at Yale University, established two classifications of biophilic design. The classifications are organic design (or naturalistic) and vernacular design (or place-based).[112] According to Kellert, organic design utilizes the shapes and forms in a built environment that evoke people's affinity with nature, for example, the use of natural materials, ventilation, light, and the integration with natural elements like water, rocks, vegetation, and ornaments that mimic natural forms. Place-based or vernacular design represents the connection between historical, cultural, and ecological aspects of a specific location to a built environment. Also known as the "sense of place," the vernacular design reflects how buildings and landscape are connected to cultural aspects of a society.[113] Biophilic design can be represented in a building's interior or exterior façade (e.g. decoration features, pictures of natural environments, and flowerpots).

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[110] Stephen R. Kellert, Judith Heerwagen, and Martin Mador, *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life* (Hoboken, NJ: Wiley, 2008), 5.
[111] Catherine O. Ryan, William D. Browning, Joseph O. Clancy, Scott L. Andrews, and Namita B. Kallianpurkar, "Biophilic Design Patterns: Emerging Nature-Based Parameters for Health and Well-Being in the Built Environment," *International Journal of Architectural Research* 8, no. 2 (July 2014): 62–75, http://www.archnet-ijar.net/index.php/IJAR/article/viewFile/436/352.
[112] Kellert, Heerwagen, and Mador, *Biophilic Design*, 5.
[113] Stephen R. Kellert, Judith Heerwagen, and Martin Mador, *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life* (Hoboken, NJ: Wiley, 2008), 6.

To better understand how to apply the concept of biophilic design to effectively enhance human beings' overall health and general wellbeing, a new framework for biophilic design was proposed in 2014 by Terrapin Bright Green.[114] Terrapin Bright Green is a New York-based green building research and environmental consulting practice that has published various articles on biophilic design, such as "14 Patterns of Biophilic Design," "The Economics of Biophilia," and "Biophilia & Healing Environments," among others.[115] Terrapin researchers describe the basis of biophilic design and how it is related to the built environment. Empirical evidence and interdisciplinary analysis of more than 500 peer-reviewed articles and books help the researchers to establish the design patterns. Derived from all this analyses, Terrapin established fourteen biophilic design patterns that can be implemented within the design of both interior and exterior environment and that focus on psychological, physiological, and cognitive benefits.

Resulting from a concept framework first described in 2008 by Cramer and Browning in *Biophilic Design*, which established that the human-nature relationship is divided into three categories—nature in the space, natural analogues, or nature of the space, Terrapin's researchers divided these three categories into fourteen patterns.[116] See Table 2.

Table 2. Biophilic Design Categories and Patterns (Terrapin Bright Green).

	Nature in the Space	**Natural Analogues**	**Nature of the Space**
Elements	Rocks Water Animal Plants	Objects Materials Colors Shapes Patterns and algorithms that evoke nature	Different spatial configurations and associated psychological and physiological responses they engender
Patterns	1-Visual connection with nature	8-Biomorphic forms and patterns	11-Prospect 12-Refuge 13-Mystery 14-Risk/Peril

[114] "Reports," Terrapin Bright Green, www.terrapinbrightgreen.com/publications/.
[115] Ibid.
[116] Ibid.

	Table 2 Continued		
	2-Non-visual connection with nature 3-Non rhythm sensory stimuli	9-Material connection with nature 10-Complexity and order	
	4-Access to thermal and airflow variability 5-Presence of water 6-Dynamic and diffuse light 7-Connection with natural systems		
Application	The presence and diversity of plant life, water bodies, animal species, and other elements from nature within the built environment (e.g., courtyards gardens, green wall, and water features)	Representational artwork, ornamentation, biomorphic forms and natural material	

Source: Ryan et al., "Biophilic Design Patterns."

The first category, “Nature in the Space,” was defined by Cramer and Browning as direct, physical presence of nature, for example natural elements such as rocks, water and plants that have been integrated in a built environment (e.g. courtyards, gardens, green walls, and water features). The Nature in the Space category is then classified by Terrapin researchers as seven distinct biophilic design patterns. The first pattern, “Visual Connection with Nature,” is described as the viewing of elements of nature and living systems. The second pattern, “Non-visual Connection with Nature,” exists as sensorial (i.e. auditory, haptic, olfactory, or gustatory stimuli) that correlates with a positive connection to nature. The third pattern is “Non-Rhythmic Sensory Stimuli,” which is described as randomly determined and ephemeral connections with nature. The fourth pattern is “Thermal and Airflow Variability,” which is described as environmental conditions (i.e. changes in temperature, humidity, airflow, and temperature) that mimic natural environments.

The fifth pattern, “Presence of Water,” is defined by seeing, hearing, or touching water. The sixth pattern, “Dynamic and Diffuse Light,” is established through varying the intensity of light and shadow. Finally, the seventh pattern, “Connection with Natural Systems,” is defined as an awareness of seasonal and temporal changes within nature’s processes.

The second category “Natural Analogues,” as defined by Cramer and Browning, exists as nonliving evocations of nature such as organic shapes, materials, colors, patterns, and algorithms that evoke nature. Terrapin’s authors identified three biophilic design patterns derived from Natural Analogues. Classified as an eighth pattern, “Biomorphic Forms and Patterns,” is described as symbolic references to patterns that occur in nature and that could be textural or numerical. The ninth pattern is “Material Connection with Nature,” which is defined by materials and elements that represent the local ecology and geology and create a distinct sense of place. The tenth pattern, “Complexity and Order,” is defined as complex sensorial information derived from a spatial hierarchy analogous to an encounter with nature.

Cramer and Browning’s third category, “Nature of the Space,” is defined as spatial configurations that resemble condition found in nature and that are associated with psychological and physiological responses. Derived from “Nature of the Space” category, four biophilic design patterns were further identified by Terrapin’s researchers and were classified as an eleventh biophilic design pattern—“Prospect.” This eleventh design is defined as an unobstructed view over a particular distance for the purposes of surveillance and planning. The twelfth biophilic design pattern, “Refuge,” is defined as a place where an individual is protected from both behind and overhead. The thirteenth biophilic design pattern is “Mystery,” which is achieved through partially obscure views or other sensory stimulus that entice the individual to investigate deeper into a respective environment.

In 2015, Kellert and Elizabeth F. Calabrese, an architect who teaches biophilic and ecological design at the University of Vermont, published a study entitled “The Practice of Biophilic Design.” As an update to the previous literature on *Biophilic Design,* this article defines three experiences and twenty-four attributes related to biophilic design.[117] See Table 3.

Table 3. Experience and Attributes of Biophilic Design Defined by Kellert and Calabrese.

Direct Experience of Nature	Indirect Experience of Nature	Experience of Space and Place
Light	Images of Nature	Prospect and Refuge
Air	Natural Materials	Organized complexity
Water	Natural Colors	Integration of parts to wholes
Plants	Simulating Natural Light and air	Transitional spaces
Animals	Naturalistic shapes and forms	Mobility and wayfinding
Weather	Evoking nature	Cultural and ecological attachment to place
Natural landscapes and ecosystems	Information richness	-
Fire	Age, change and the patina of time	-
-	Natural geometries	-
-	Biomimicry	-

Source: Kellert, S. and Calabrese, E. 2015. The Practice of Biophilic Design.

According to Kellert and Calabrese, the direct experience of nature is defined as actual contact with natural elements such as light, air, animals, water, and landscapes, on a built environment. Kellert and Calabrese defined the indirect experience one has with nature as the contact one experiences with an element that represents or resembles nature or natural patterns, for example pictures or artwork that depict nature, shapes and forms that occur in nature, natural material applied to furniture or fabrics, natural geometries and process that evoking nature. Lastly, the

[117] Kellert and Calabrese, *The Practice of Biophilic Design*, 10.

experience of space and place is related to spatial configuration of natural spaces that has positive impact on human health and wellbeing, for example spaces that have opportunities for experiment characteristics of prospect, refuge, mobility, organized complexity and more. The author defined these classifications as a collective framework to be used as a practical methodology to be apply to achieve a better design. Thus, this study explores the many opportunities to apply biophilic design principles to the creation of playgrounds for children utilizing vacant spaces within the urban fabric.

2.4 Summary

The prediction is that, by 2030, almost 5-billion people will be living in urban areas. See figure 33.

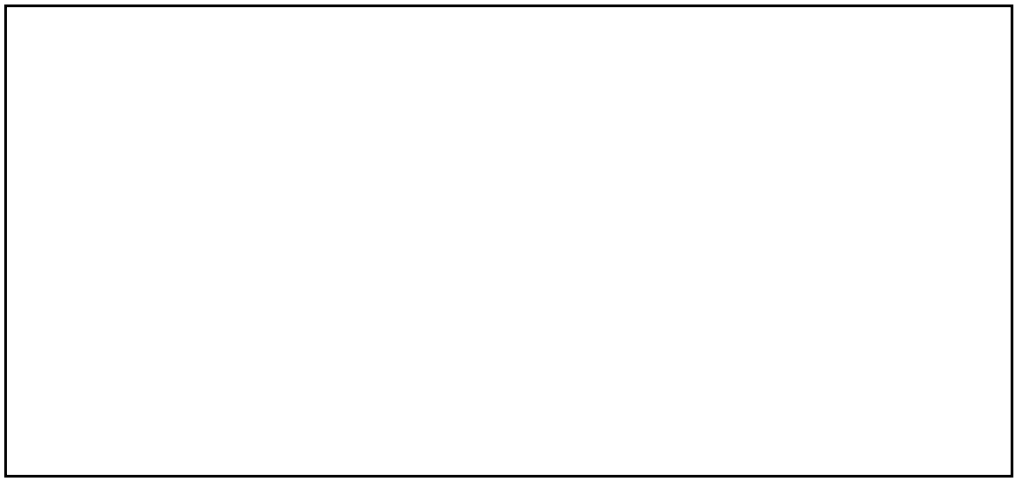

Figure 33. Global population, including the portion of rural and urban populations, from 1950 to predicted levels in 2050. (Reproduced from http://www.unfpa.org).

In modern society, a majority of the western population chooses to live within dense urban areas primarily because these areas offer greater economic opportunities for inhabitants.[118]

Urbanization is defined both by the phenomenon of people's migration from rural areas to urban areas and also by the naturally growing—based on the number of births compared to the number

[118] http://www.unfpa.org

of deaths—of a given population of urban centers.[119] In both cases, to sustain population growth, most dense urban cities lack green spaces in favor of built spaces, and nature is often scarce in urban context as if unnecessary. Consequently, urbanization ends up having a negative impact on the existence of urban green spaces.[120] Due of the importance of these green spaces for the overall development of urban area residents, access to green space in a city is currently recognized as an environmental justice issue. [121]

One of the consequences of the accelerated growth of city spaces within the U.S. is that human beings are continuing to lack basic contact with nature in urban settings, and, as such, they are alienating themselves from the natural world still possible of being either maintained or re-established within a given city.[122] Regardless of the evidence that demonstrates this importance of human contact with nature, the rapid, demand-based growth of urban areas is demanding that urbanization continues to replace open and natural spaces with built environments. The obvious consequence is the diminishing of human contact with natural settings. Besides providing critical ecosystem services, green spaces in a city are responsible for promoting the overall health of urban dwellers.

Since many individuals within the U.S. are choosing to live in urban centers for the sake of overall monetary wellbeing, it is important for architects and urban planners to design attractive natural spaces in cities that promote a positive environment for children to experience daily contact with nature. Cityscape design always considers the presence of automobiles, bicyclists, and pedestrians, but children's play spaces are largely ignored within the design of cities. Creating

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[119] http://pubs.iied.org
[120] Kong and Nakagoshi. "Spatial-Temporal Gradient Analysis of Urban Green Spaces in Jinan, China." 147–164
[121] Wolch, Byrne, and Newell, "Urban Green Space," 234–244.
[122] David W. Orr, *The Nature of Design: Ecology, Culture, and Human Intention* (Oxford, UK: Oxford University Press, 2002), 32.

natural and attractive spaces that are especially designed for children's play will entice them to play outdoors and contributing for their overall health and development.

Cities might offer natural environments for their citizens in the form of parks or nature reserves. However, according to Robert Pyle, who has a doctorate in ecology and environmental studies from the Yale School of Forestry & Environmental Studies, urban parks are typically "too manicured and chemically treated to offer much of interest to the adventuring of youngster."[123] Pyle believes that urban parks do not always provide a rich environment for children to play with creativity and freedom. He declares, "For special places to work their magic on children, they need to be able to do some clamber and damage. They need to be free to climb trees, muck about, catch things and get wet—above all, to leave the trail."[124] Therefore, to encourage children to go to outside of their homes to play, spaces have to be attractive for them (e.g. parks and green areas that arouse the interest of children and stimulate their creativity and curiosity.

In Pyle's opinion, parks that include a bench and a big tree that children cannot climb might not serve as stimuli for them, and he believe that natural places that are more attractive for children are the ones that have less human "interference," like abandoned lots where nature take over. Pyle also explains that certain groups of people encounter more difficulty than others when it comes to experiencing contact with a natural environment in urban cities. These individuals are more dependable regarding what he calls the "radius of reach," which is defined by the nearby availability of natural setting to experience nature.[125] As examples, he lists people with low income who cannot afford trips to places with natural environments or people with challenges regarding independent transportation (such as the elderly or children who do not have the autonomy of getting around by themselves). Therefore, the following question arises. How can

[123] Kahn and Kellert, *Children and Nature*, 169.
[124] Pyle, "Eden in a Vacant Lot," 305–327.
[125] Ibid.

architects, landscape architects, and urban planners create more opportunities to facilitate children's contact with nature within dense, urban areas?

The urban fabric is often dotted with residual vacant lots and underutilized spaces. For this project, those spaces will be considered for their potential as insertion points for small green spaces and, as such, places to play. According to the United States Environmental Protection Agency (EPA), a vacant lot is "a neglected parcel of property that has no building on it."[126] In dense, urban areas, the disorderly way of urbanization often leads to the seeking out and utilization of leftover available spaces. These available spaces might be too small to become a park, but they can be great opportunities to creatively implement small green areas for people to experience daily doses of nature.

There are various designations for land that is underutilized or does not exist with human intervention, for example "raw land," "waste ground," "residual spaces," and "vacant lots," among others. A vacant lot is a more common designation for land that "is a neglected parcel of property that has no buildings on it."[127] According to the United States EPA, vacant lots can be problematic spaces for urban communities if used illegally as a space for dumping litter, and they can be contaminated with hazardous substances.[128] In addition, the EPA points out that vacant lots can disturb a neighborhood's sense of community and attract pests. The EPA states that, to avoid these concerns, such lots have to be reclaimed as productive pieces of land.

Due to the densification of urban centers and the subsequent lack of available square footage, a small piece of land can be an especially valuable and useful space within a city for a playground.

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[126] "What are Vacant Lots?" United States Environmental Protection Agency, https://www3.epa.gov/region1/eco/uep/vacantlots.html.
[127] "Ibid.
[128] Pyle, "Eden in a Vacant Lot," 305–327.

If well designed, this space allows for opportunities for it to be inserted into an urban fabric as a natural and/or built environment that brings benefits to the neighborhood and the community.

Professor from the Yale School of Forestry & Environmental Studies Robert Pyle describes the emotional affinity that some people have with a vacant lot near their childhood homes, and he identifies some characteristics that were shared among these people. Most of them described the "vacant lot" of their childhood as spaces with water sources (e.g. creeks, ponds, and streams) along with tall trees or undeveloped parks. Those spaces were qualified by their "nearness, wildness, secretiveness, and possibility." He continued to describe how these places had an impact on individual's lives, and he, unfortunately, concluded that these spaces have changed or no longer exist. Pyle recalls that vacant lots used to be significant places for a "special group of users" (i.e. children).[129] According to Pyle, vacant lots were places outside of the home where children used to go to play and where they could experiment and explore a natural environment that had no human interventions.

"Our city needs to maintain the natural habitats of children undedicated, unmanaged, undeveloped ground where unplanned, unsupervised, and unexpected discovery can take place."[130] Pyle proposes that spaces that are more attractive to children are the ones that have less human interference. These spaces require less maintenance and appear wilder, providing opportunities to connect young visitors with land and natural elements. Utilizing a vacant and underutilized lots as a space to insert nature into a child's life through a play area is a way to solve many problems at once.

[129] Pyle, "Eden in a Vacant Lot," 305–327.

[130] Ibid.

Knowing how important nature is for children's overall development, along with their respective imagination, emotional wellbeing, and creativity, it is imperative that architects and urban planners prioritize the insertion of nature within urban spaces in a way that facilitates daily contact. Vacant lots as available and underutilized lots can provide an opportunity to promote this daily encounter because they are abundant within the urban fabric of many cities.

Promoting the insertion of nature into spaces that are a walking distance from one's home decreases Pyle's "radius of reach," which is defined by the nearby availability of natural setting to experience nature.[131] In addition, it will facilitates access to natural environments in people's daily lives.

The literature review was conducted to demonstrate the importance of contact with nature for overall human development, particularly that of children. A biophilia hypothesis asserts that daily contact with nature is a biological need, and it was used as a framework to demonstrate the crucial importance of human and nature relationship. The connection between children's overall health and nature was explored through empirical studies, which describe the importance of this connection for children's physical, psychological, and emotional health. Research demonstrating the importance for children to play in contact with nature and their preference for natural environments was reviewed. The playgrounds design overview was explored to understand how and why the design of space for children to play has changed over time. Understanding that safety issues became the primary drivers for the design of the majority of contemporary playgrounds within the U.S., an examination into playgrounds safety and overall accessibility was necessary.

[131] Ibid.

Biophilic design was then researched in order to establish an agenda that addresses opportunities to positively insert natural elements into the design of urban playgrounds. Biophilic design has being widely applied across many building typologies and scales since its 1900s impetus. However, as of 2017, a lack of information exists regarding the application of biophilic design into playgrounds. In order to fill this gap, the aim of this dissertation is to address the positive application of biophilic design principles into the design of urban playgrounds. Recognizing that urbanization is responsible for the lack of daily contact with nature in a built environment, I am proposing vacant lots as available and underutilized spaces as opportunities to insert playgrounds integrate with nature in dense urban areas of any U.S. city, thus increasing chances for children to be in contact with nature.

3 Chapter 3: Playground Design

Within the literature review section of this dissertation, the importance of the contact with natural elements for children's physical, psychological, and emotional development was presented. As such, the concept of the playground exists as an opportunity to establish a way for individuals, especially children, to connect with nature within dense urban areas. The biophilic design concept seeks to promote a beneficial contact between human beings and nature within a built environment. Thus, my proposal applies key concepts of biophilic design within the design of playgrounds to allow and possibly encourage children, many of whom lack contact with nature given their living spaces, to be able to obtain more opportunities to be in contact with nature. By analyzing the history of playgrounds, I acknowledge that playgrounds today do not often support children's overall development as they once may have. Safety issue became the basis for design guidelines and the initial purposes of playgrounds lost their meaning. Consequently, children may have lost opportunities to play in environments that wholly stimulate their overall development. Therefore, I am proposing a new criterion for the design of small urban playgrounds. I believe

that, in order to create a playground that is attractive and a stimulating place for children, the safety issue alone cannot be the primary driver for the design. My approach is not to ignore all safety concerns that have been thoughtfully established through standards and guidelines but to explore a hybrid approach that offers communities a set of practical applications for the design of playgrounds in their neighborhoods.

3.1 Biophilic Design Application on Playgrounds

Within the “Biophilic Design” section I described the biophilic design patterns defined by Terrapin Bright Green and biophilic design attributes defined by Kellert and Calabrese. Biophilic design patterns exist as strategies that can be combined to enhance the biophilic experience to benefit people within a built environment.[132] However, not all biophilic design pattern and attributes are valid for all architectural design typologies, and they can be combined and overlapped regarding a specific project’s needs and overall intent. For example, a biophilic design pattern that connotes “mystery” might not be appropriate and effectively implemented when applied on a design of a healthcare facility, but it could be a stimulating pattern when applied on a design of playground. Terrapin Bright Green adopted the term “pattern” to describe their perception of biophilic design, while Kellert and Calabrese adopted the term “attribute.” Since, for the purposes of this dissertation, I have decided to combine some biophilic design patterns with some biophilic design attributes, I have personalized the terminology to be referred to as “biophilic design principles” when I am describing the combination of patterns and attributes.

[132] William Browning, Catherine Ryan, and Joseph Clancy, "14 Patterns of Biophilic Design: Improving Health and Well-Being in the Built Environment," Terrapin Bright Green (2014): 4.

The decision about which biophilic design principles will be the most beneficial for a specific design depends on various factors (e.g. user's, programming, geographical climate, and respective culture).[133] Therefore, the primary question for this dissertation becomes which biophilic design principles are the most beneficial for children when applied to a playground design? To help answer this question, I first identified some characteristics of children's preference of spaces to play, described previously in the chapter "Children and Play." By analyzing children's preference of spaces to play, I found similar characteristics between children's preference of spaces to play and some specific biophilic design principles. These similarities helped me to define the biophilic design principles that will be the most appropriate, and consequently most beneficial, for children when applied on a playground design. See Table 4.

Table 4. Biophilic Design Principles and Children Preferred Space to Play.

Biophilic Design Principles	**Children Preferred Spaces to Play**
1. Visual/non-visual connection with nature 2. Connection with natural systems 3. Natural colors 4. Water 5. Plants 6. Biomorphic forms and patterns 7. Mystery 8. Prospect 9. Refuge 10. Risk/Peril.	● Children prefer to play in natural settings (Peter Kahn and Stephen Kellert, Kalevi Korpela, Robin Moore, Mary Ann Kirkby). ● Children like the presence of nature and animals. (Sharareh Ghanbari-Azarneir, Sara Anbari, Seyed-Bagher Hosseini, Seyed-Abbas Yazdanfar,). ● Children have an innate preferences for colorful play spaces. (Sharareh Ghanbari-Azarneir, Sara Anbari, Seyed-Bagher Hosseini, Seyed-Abbas Yazdanfar) ● Enclosed spaces, that allow visual connection to the surround and provide a sense of privacy and safety. (Mary Ann Kirkby). ● Refuges and places to hide are highly attractive for children (Mary Ann Kirkby, and Sharareh Ghanbari-Azarneir, Sara Anbari, Seyed-Bagher Hosseini, Seyed-Abbas Yazdanfar). ● Children like to take some risks, as they classified some attractive spaces as being "scary" and "excited" as hiding places (Sharareh Ghanbari-Azarneir, Sara Anbari, Seyed-Bagher Hosseini, Seyed-Abbas Yazdanfar

[133] Ryan, "Biophilic Design Patterns," 62–75.

Besides these ten biophilic design principles, that I selected based on children's preference of spaces to play, I also include other biophilic design patterns and attributes that I have identified through research as they been determined to be appropriate for the design of a playground. Among the fourteen patterns of biophilic design described by Terrapin Bright Green,[134] I selected eleven patterns to be combined with five attributes described by Kellert and Calabrese in "Experience and Attributes of Biophilic Design".[135] I choose to combine the patterns from Terrapin and attributes from Kellert and Calabrese because I found that they are similar in content and yet distinctly complementary. I propose that combining this two classification of biophilic design will allow for a holistic approach to be applied on a design of a playground. I have selected sixteen biophilic design principles (i.e. patterns and attributes) that I consider to be relevant for the design of a playground in the selected study sites. See Table 5.

Table 5. Biophilic Design Principles to be Applied on a Design of a Playground.

CATEGORIES			
	Nature in the Space	**Nature Analogous**	**Nature of the Space**
PATTERNS Terrapin Bright Green, 2014	1. Visual connection with nature 2. Non-visual connection with nature 3. Presence of water 4. Dynamic and diffuse light 5. Connection with natural systems	6. Biomorphic forms and patterns 7. Material connection with nature	8. Prospect 9. Refuge 10. Mystery 11. Risk/Peril
EXPERIENCES			
	Direct Experience of Nature	**Indirect Experience of Nature**	**Experience of Space and Place**
ATTRIBUTES Kellert & Calabrese, 2015	1. Plants	2. Images of Nature 3. Natural Colors	4. Transitional spaces 5. Cultural and ecological attachment to place

[134] Ryan, "Biophilic Design Patterns," 62–75.
[135] Kellert and Calabrese, *The Practice of Biophilic Design*, 10.

As can be seen in Table 5, I have selected a total of sixteen biophilic design principles that I propose are appropriate to be applied within the design of a playground. However, a critical question remains. How can biophilic design principles that were selected be expressed within the design of a playground to create a positive biophilic response for children who live in a dense, urban environment?

3.1.1 Biophilic Design: Spatial Investigation

To investigate opportunities for applying biophilic design principles within the design of a playground, I explored natural forms and shapes regarding the expression of specific biophilic design principles. My intention was to incorporate diverse aspects of a biophilic design principles into a form that can be applied within the design of a playground to maximize a positive biophilic outcome experiences for users. The biophilic design categories of “Nature of the Space” and “Experience of Space and Place” refer to spatial configuration that occur in nature and promote a biophilic responses (e.g. human beings’ natural desire to be able to see their surroundings, their natural attraction to a things that are slightly dangerous or unknown, or their respective desire to take risks but with a presence of a safety element). First, I investigated the spatial characteristics of four biophilic design patterns that I selected from the “Nature of the Space” category, including refuge, prospect, risk/peril, and mystery. The following diagram represents a spatial configuration and the related characteristics of four biophilic design principles (i.e. refuge, prospect, risk/peril, and mystery), which will be applied to my proposed design for a playground. See Figure 34.

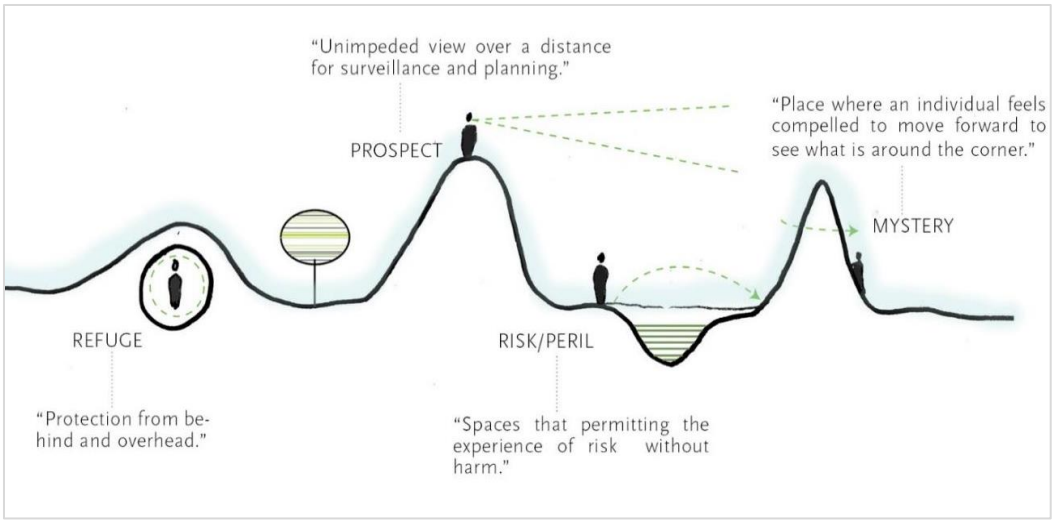

Figure 34. Spatial Configurations in Nature of a Biophilic Design Pattern: Nature of the Space.

3.1.1.1 Refuge

The definition of refuge is "a place that provides shelter or protection."[5] Many design strategies exist that can be combined to provide a sense of refuge. To achieve a solid sense of refuge, the spatial configuration of place has to provide protection from behind and overhead and promote a sense of resting, protection, and healing.[136] Shapes and forms that allow this biophilic outcome are small, enclosed, or semi-enclosed spaces that could provide vistas to the outside and protection from natural conditions. See Figure 35.

Figure 35. Diagram of Refuge Type of Setting.

[136] Browning, Ryan, and Clancy, "14 Patterns of Biophilic Design," 46.

An effective sense of refuge can be enhanced if combined with prospect characteristics providing a capacity to "observe (prospect) without being seen (refuge)."[7] The factor height can be incorporated into a refuge-based space to enhance the prospect/refuge characteristics. See Figure 36.

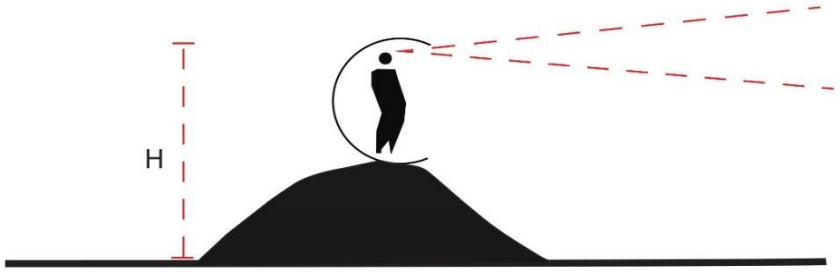

Figure 36. Diagram of Prospect Combined With Refuge Type of Setting.

3.1.1.2 Prospect

Prospect is defined as "a place that commands an extensive view."[137] While refuge provide a sense of safety and security, prospect allows for a sense of surveillance and planning.[138] Spatial configurations regarding prospect can be archived with elevated spaces that provide an overview of the immediate surroundings. See Figure 37. The diagram below represents a prospect situation that can allow for viewing and visual experimentation when an individual has an unobstructed view from an elevated space. In this case, a factor of height is presented.

[137] "Prospect," Merriam-Webster, https://www.merriam-webster.com/dictionary/prospect.
[138] Browning, Ryan, and Clancy, "14 Patterns of Biophilic Design," 44.

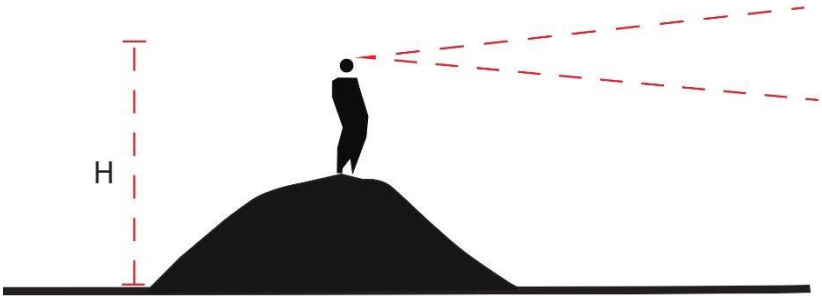

Figure 37. Diagram of Prospect Type of Setting.

To obtain a sense of prospect, a preferred distance from the observer should not be less than 30 meters.[139] There are a variety of ways to achieve a spatial configuration of prospect. It could also be achieved by creating a design that provides users with an ability to see from one space to another or to see through multiple spaces without any barriers. See Figure 38. In Figure 37, the factor of height is not presented; however, a prospect-based condition is achieved through open spaces with no obstructed views.

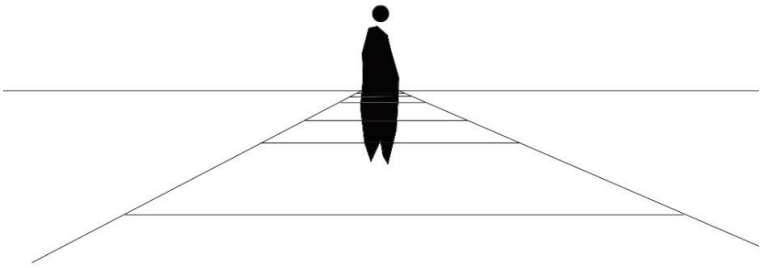

Figure 38. Diagram of Prospect Type of Setting.

[139] T.R. Herzog and Anna G. Bryce (2007). ”Mystery and Preference in Within-Forest Settings,” *Environment and Behavior* 39, no. 6 (November 2007): 779–796, https://doi.org/10.1177/0013916506298796.

3.1.1.3 Risk/Peril

A biophilic design principle of risk/peril is defined as “spaces that permitting the experience of risk without harm.”[140] Some elements that can be involved in a risk/peril situation include height, gravity, speed, water, and fire, among other elements, (e.g. a sense of falling, a loss of control, or getting wet). The following diagram represents a risk/peril condition where there exists a notion of the risk of falling; however, the water below a bridge and the low elevation component gives a sense of security. See Figure 39.

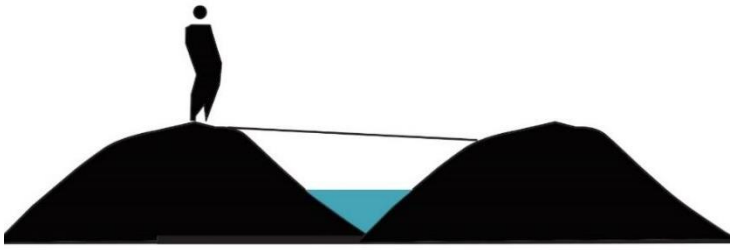

Figure 39. Diagram of Risk/Peril Type of Setting.

Another example of spatial configuration of risk/peril is demonstrated within the following diagram where the risk of getting wet is involved if the individual decides to take another step. See Figure 40.

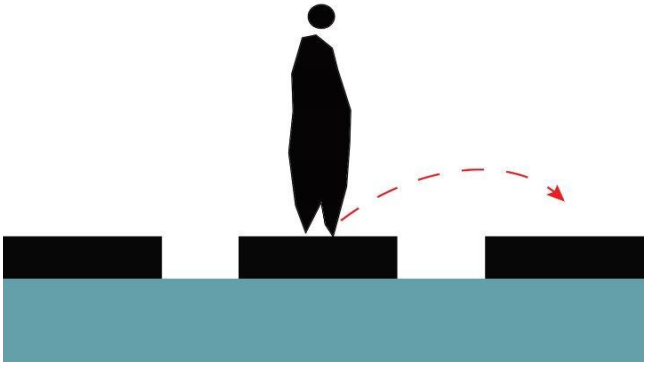

Figure 40. Diagram of Risk/Peril Type of Setting.

[140] Browning, Ryan, and Clancy, “14 Patterns of Biophilic Design,” 50.

3.1.1.4 Mystery

The term “mystery” can be defined as “something not understood or beyond understanding.” s[141] Mystery as a biophilic design concept originate from the idea that “people have two basic needs in environments: to understand and to explore.”[142] A biophilic design principle of mystery is further defined by Terrapin Bright Green as “the promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment; it is the partially revealed view ahead.” In addition, according to Terrapin researchers, mystery can be expressed through spaces that offer a “sense kind of denial and reward that compels one to further investigate the space.”[143]

Unlike other biophilic design principles previously described, mystery can be experienced when one is in an immobile position. Mystery requires movement from the spectator in order to be manifested. A spatial configuration with a substantial sense of mystery encourages exploration through the respective space with a sense of reward at the end.[144] The experience of mystery might diminish with a regular exposure to it; therefore, strategies that encourage changing or rotating within a given context are more effective for creating the sense of mystery. One example of a spatial configuration of mystery is demonstrated within the following diagram. See Figure 41.

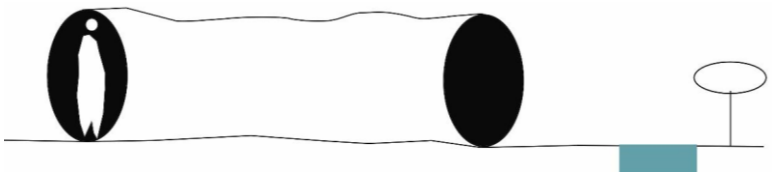

Figure 41. Diagram of Mystery Type of Setting.

[141] “Mystery,” Merriam-Webster, https://www.merriam-webster.com/dictionary/mystery.
[142] Browning, Ryan, and Clancy, “14 Patterns of Biophilic Design,”48.
[143] Ibid.
[144] Browning, Ryan, and Clancy, “14 Patterns of Biophilic Design,”49.

The Mystery Diagram represents a mystery-based condition as experienced by the spectator who does not have a clearly revealed view ahead of him or her. The water and tree at the end of the tunnel represent a reward that will motivate the individual to further investigate the space.

Through the previous seven diagrams, I have identified spatial characteristics that were defined based on biophilic design principles, and I propose that these spatial characteristics be used as a guide for the design of playground elements and overall layout. Specifically, the diagrams were designed based on a biophilic design pattern of “Nature of the Space;” however, the experience of “Nature of the Space” is enhanced if combined with patterns of “Nature in the Space” and “Natural Analogues.”[145] I have selected 16 biophilic design principles from all different categories and attributes to apply within prospective playground design. The spatial investigation of the biophilic design principles of refuge, prospect, risk/peril, and mystery help to identify spatial configurations that can be applied to the design of elements of a playground to create a more biophilic experience. The play elements of the playground can be designed based on these spatial configurations and can also be used as design guidelines for the application of biophilic design principles within playground site design.

[145] Browning, Ryan, and Clancy, “14 Patterns of Biophilic Design,” 14.

4 Chapter 4. Design Guidelines

The choice of which biophilic design principle is the most suitable for each project varies according to the type of project, economic and cultural factors, and the size of the project, among other elements.[146] Playgrounds have typically consisted of play elements or equipment simply placed upon a given site. To establish a guideline for the application of biophilic design principles into the design of playgrounds, I have created a matrix that will serve as a guide for designers to apply biophilic design principles into the design of playgrounds. See Table 6. This matrix was created based on the 16 previously identified biophilic design principles (i.e. patterns and attributes) and their relationship with spatial configuration and design consideration.

Table 6. Biophilic Design Guidelines for Playgrounds.

Biophilic Design Principles Applied to Playgrounds		
Biophilic Design Principles	**Spatial Configuration**	**Design Consideration**
1. Visual Connection with Nature	Spaces and play elements integrated with nature	Nature as part of a play elements
2. Non-Visual Connection with Nature	Spaces with a positive sensorial stimulus that resemble nature	Features that promote sounds of water and a garden with edible plants
3. Presence of Water	Spaces and play elements integrated with water	Fountain, rain garden, water channel, etc. integrated with play elements and overall site design
4. Dynamic and Diffuse Light	Play elements or spaces that allows dramatic light and shade	Diversified openings for varied sunlight incidences
5. Connection with Natural Systems	Integration with natural systems	Rain garden and deciduous trees as part of site design and overall landscape
6. Biomorphic Forms and Patterns	Spaces with organic shapes and patterns and avoidance of right angles	Utilization of curves and organic shapes to design play elements and overall site design
7. Material Connection with Nature	Spaces designed with natural materials	Wood, stone, and sand integrated with play elements and overall site design

[146] Kellert and Calabrese, *The Practice of Biophilic Design*, 13.

Table 6 Continued		
8. Prospect	Spaces that allows open views beyond the immediate surroundings	Elevated spaces that allow for unobstructed views and play elements that can be climbed
9. Refuge	Spaces that promote protection from behind and overhead	Enclosure type of play element and spaces that promote a sense of protection and rest
10. Mystery	Spaces that encourage one to further investigate and that promote a sense of reward at the end	Curved edges with the use of dramatic light and shade within play elements and spaces and with obstructed or unreachable view
11. Risk/Peril	Spaces that permitting the experience of risk without harm	Play elements or spaces that allow for experiment with height, gravity, speed, and water (e.g. perception of falling or getting wet)
12. Plants	Spaces integrated with plants	Gardens with trees and other plants.
13. Images of Nature	N/A	Sculptures of animals or plants and play elements with shapes of nature (e.g. animals and plants)
14. Natural Colors	Colors applied to play elements and site design	Pastel and earth tones with the avoidance of bright colors
15. Transitional Spaces	Clear and visible transitions with connections between spaces	Threshold, portal, or areas that link the indoors with the outdoors
16. Cultural and Ecological Attachment to Places	Spaces that promote an ecological connection to a place	Use of indigenous flora and locally available material

4.1 Design Criteria

My approach for the design criteria of a playground is primarily based on the application of biophilic design principles. However, I believe that some recommendations from the standards (described within the Appendix of this dissertation) can be effectively applied if combined with biophilic design principles. The National Program for Playground Safety defined a set of

standards to be followed as guidelines to properly implement playgrounds.[147] Despite the fact that some architects and design researchers have wholly adopted these standards as guidelines for the design of playgrounds, with exception of Americans with Disabilities Act (ADA), none of these standards and guidelines have become a federal law. However, I have adopted some of the recommendations from the standards so as to apply them in combination with key biophilic design principles to improve the design of today's playground.

4.2 Criterion for Site Selection

4.2.1 Dense Urban Areas

The first criterion for site selection is that a given space could be a private or public available or underutilized site located in a dense urban area. Dense urban areas lack green spaces, and available lots and underutilized spaces might be opportunities to insert playgrounds, given that accommodation, funding, and restrictions are all met. The intent of this criterion is to increase green areas in dense urban settings.

4.2.2 Public Versus Private Constraints

The sought after advantage of privately funding the development of a playground is that non-profit organizations are not bound by the same safety guidelines as municipal play programs and, thus, are allowed to be more lenient regarding accountability in regards to risks; therefore, they have the potential to be more innovative when it comes to design.[148] However, such programs are especially vulnerable when it comes to funding, a characteristic that is most vividly embodied in areas where families are not able to account for the safety-based risks presented to their children. In these cases, privately-owned land would still be ideal for development with governmental support. In the case that the site is municipally-owned, land development must give way to governmental safety restrictions. In such an instance, accountability and program funding rests under with the respective municipality. The commonality between privately and publicly owned

[147] "Standards." National Program for Playground Safety.
[148] Moore, "Playgrounds at the Crossroads," 83–121.

land requires that site development must give way to existing zoning codes. Particularly in dense urban areas, complex land use regulations may result in undevelopable and consequently vacant land. Therefore the amendment of present zoning codes, if even possible, must take place prior to any site development.

4.2.3 Residential or Mixed-Use Walkable Neighborhood

A walkable neighborhood will allow for access to a playground that is on the way to parents' and children's daily activities. As previously discussed in this dissertation, playgrounds should be located in a residential or mixed-use walkable neighborhood, where children can have easy access to the playground and, through such a design, will increase their opportunity to have a daily access to nature.

4.2.4 Avoid Arterial Roads

The CPSC Handbook recommends that the travel pattern children should follow to reach a given playground should be free of any potential hazard (e.g. roads with heavy traffic, lakes, streams, or cliffs).[149] Therefore, available and underutilized lots along heavily travelled roads or streets that are not well signposted should be avoided in order to limit children's exposure to automobiles, air pollution, and other safety concerns. Preferences should be given to lots located close to streets with minimal traffic with well-designed sidewalks that allow people to walk comfortably and safely.

4.2.5 Close to Schools and Home

Children will have more opportunities to experiment with nature in their everyday lives if a playground is constructed near their respective home and school.[150] The location of a playground should be along children's walking routes between schools and residential neighborhoods. The preference is to select an area around schools that house children from kindergarten to eighth

[149] U.S. Consumer Product Safety Commission, "Public Playground Safety Handbook," U.S. Consumer Product Safety Commission 325, (November 2010): 5, https://www.cpsc.gov/s3fs-public/325.pdf.
[150] Pyle, "Eden in a Vacant Lot," 305–327.

grade with a high number of children enrolled. The intent of this criterion is to reach a large number of children within a given area.

4.2.6 Site Typologies

The criterion for site typologies selection include private or public available and underutilized lots that might also include vacant or underutilized mini parks that need revitalization, alleys, and parking lots. The intention of this criterion is to broaden the site opportunities within a selected area. See Figure 42.

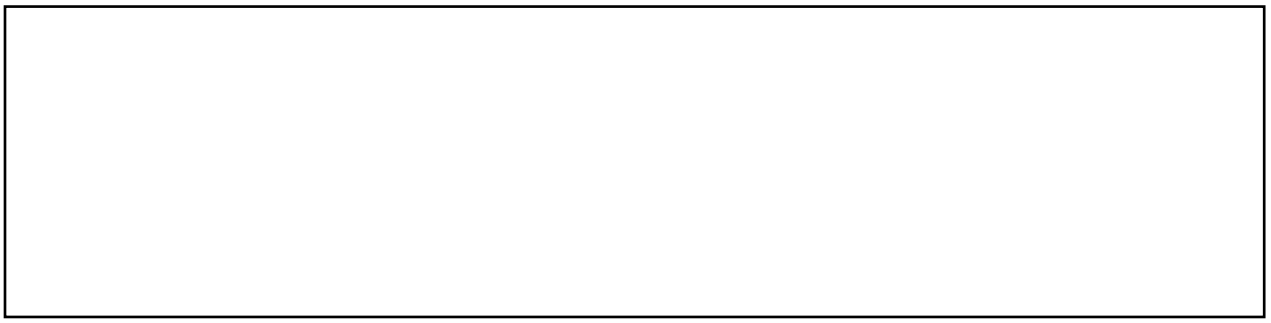

Figure 42. Typologies of Underutilized Spaces.

4.2.7 Minimum and Maximum Square Footage

Available lots or underutilized spaces might provide an opportunity for the design of playgrounds in dense, urban areas. However, these spaces are often irregular and fragmented spaces of the urban fabric with variable footage and shape. The design of a playground should be adapted to the available site, and the configuration of each area of the playground has to be adapted according to the site availability. Since what matters is not the extension of the green area but the easy access to small doses of nature each day, the intention of this criterion is to maximize the opportunity of available spaces that can be used as a playgrounds for children to be in contact with nature.

4.3 Criteria for Playground Layout

4.3.1 Age Separation

Playground designers should consider that children with diverse ages are in different stages of development and, therefore, have various needs and physical abilities. Thus, the playground should ideally be divided into different areas for children of different ages, each possessing equally diverse developmental criteria. The criteria for age separation will follow the age classification defined by the CPSC handbook. It classifies children's ages as the following: toddlers (6 months through 23 months of age), preschool-age children (2 years through 5 years of age), and school-age children (5 years through 12 years of age). The CPSC handbook assumes that there might be overlapping development patterns that happen for children 2 to 5 years old. For example, specification for play equipment designed for 2-year-old children might be used for 3-year-old children. To avoid conflicting activities within a given playground space, this criteria establishes that each area of the playground will have a play element that is appropriate for that specific age range. The playground's layout criterion establishes that the playground will be divided into three areas with an overlapping area according to children's ages. However, because the overall playground design depends on the size of the available lot, not all three age-based areas can necessarily fit together on the same site. So, there might be a situation where a lot will not be able to accommodate all three age groups. These criteria increase opportunities to use vacant and underutilized spaces that are spread out within the neighborhood or city. Every vacant or underutilized site is seen as a potential site for the implementation of a playground, and it will not be limited by the size of available lot. However, preferences should be given to lots that can fit all three areas of the playground on the same space.

4.3.2 Adult Supervision

Despite of the fact that playgrounds should have separate areas for different children's' ages, the CPSC handbook recommends that parents or caregivers should be able to have an overview of all the various areas of the playground. For example, a parent who is in an area designated to

two-year-old children might have an older child playing in another area. Thus, accommodating, comfortable, and shaded spaces including benches for parents and caregivers should be provided.

4.3.3 Perimeter and Adjacencies

Some methods to contain children within the playground should include, fences, walls, or dividers. Benches, plants, and specifically designed play elements can be located so as to define the perimeter and adjacencies.

4.3.4 Accessibility

In 1990, The ADA approved a nationally mandatory rule that prohibits discrimination based on disability, and they established guidelines to facilitate access for all to play equipment. All play areas should be in minimum compliance with U.S. Access Board guidelines regarding play areas. See Appendix.[151]

4.3.5 Materials

The criteria for material selection for the design of playground include specifications for play elements and for the layout's ground surface. The criteria will be defined according to a biophilic design principle regarding applying natural materials to such playground design. The materials to be considered for this category include the following: wood, clay, natural fibers, stones, sand, native metal, and some composites material like concrete, cast stone, terrazzo, and natural materials. Neutral colors will be considered for all material's application.

4.3.6 Surfacing

The CPSC considers the "critical height" of any playground structure as the "fall height below which a life-threatening head injury would not be expected to occur."[152] The ASTM F1292—the Standard Specification for Impact Attenuation of Surface System Under and Around Playground Equipment—provides the "critical height" rating of surfaces. The material surface and the height,

[151] https://www.access-board.gov
[152] U.S. Consumer Product Safety Commission, "Public Playground Safety Handbook," 3.

where the equipment will be installed, should comply with ASTM F1292. In addition, using loose-fill material that meets the ADA accessibility guidelines can be considered (See Appendix). This criterion establishes preferences for natural materials within the context of biophilic design principles. Some examples of appropriate surface natural materials that can be applied under or around playground equipment and that are described within the CPSC the handbook are pea gravel, sand, wood mulch, and wood chips. Engineered wood fiber (EWF) is a wood product, similar in appearance to landscape mulch but is specifically designed for playgrounds.

4.3.7 Program

The program of a playground must take into consideration the various users of the given space. Even though a playground exists as a place designed for children to play, the design of playgrounds must still provide spaces for adults to comfortably supervise their children, which, in turn, might increase a chance that parents will take their children to play in that respective playground. Playgrounds can also be a place for socialization that allows community members to gather and engage in conversation while their children play. The design of playgrounds should promote spaces where parents and caregivers can enjoy themselves while also benefitting from the biophilic design experience.

5 Chapter 5. Site Selection

5.1 Dense Urban Area

The City and County of Honolulu has the highest density in urban areas among all Hawaii counties with 4,300 persons per square mile.[153] The Primary Urban Center (PUC), defined by the Department of Planning and Permitting, is intended to accommodate major growth in population into the future. See Figure 43.

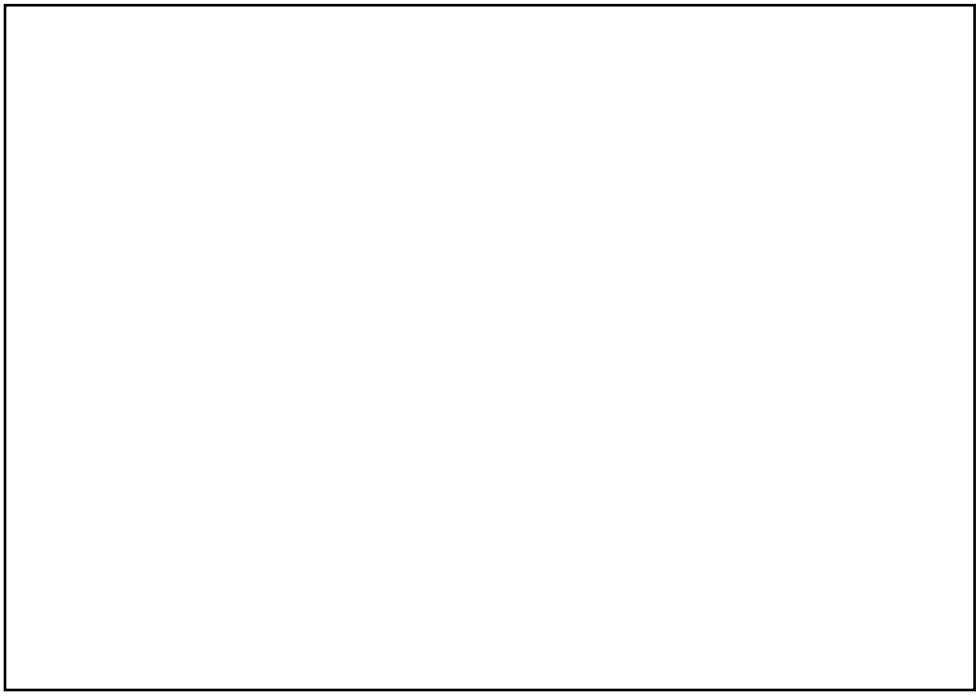

Figure 43. Development Plans and Sustainable Communities Plan Areas for Oahu, HI. (Reproduced from https://www.honolulu.gov/rep/site/ocs/roh/SCP_DP_PrimaryUrbanCenter.pdf).

The Development Plan for the PUC includes policies to protect and enhance natural resource in more populated areas. It also includes provisions for parks and recreation areas so as to invite

[153] Hawaii State Data Center, "Urban and Rural Areas in the State of Hawaii, by County: 2010," 2.

people and promote positive social interaction.[154] The PUC Development Plan (DP) is a regional plan intended to guide development decisions in support of population projection for Oahu's most populated area, which includes several neighborhood Transit-Oriented Development (TOD) planning areas. This PUC DP includes, among others things, mixed use land and pedestrian and park improvements with streetscape and landscape improvements on routes that are connected to neighborhoods (e.g. broad promenades, pocket parks, and connected sidewalk network) as well as improvements to promote alternative modes of transportation including bus transit, pedestrian mobility, and bicycle use. [155]

While there exist no remaining large open and developable land areas, the PUC area has vacant lots that can be designated to green spaces.[156] The acquisition of additional park space in the PUC area is constrained by high real estate values, as well as a limited number of vacant parcels that meet the city's size requirements and exposure to external disturbances (e.g. noise level and increased crime) However, there are some incentives and innovative approaches to implement the acquisition of new recreational spaces in the PUC area. For example, the City and County of Honolulu can partner up with the State Department of Education (DOE) and private, nonprofit organizations to jointly use, develop, or improve recreational facilities. In addition, tax contributions from the private sector can be optimized by park dedication to private vacant spaces.

5.2 Close to TOD Station

The criterion for site selection establishes that the site has to be in a residential walkable neighborhood to facilitate access to playgrounds. Transit-oriented development (TOD) refers to developments that are walking distance to a transit stop. TOD plan focuses on transforming the

[154] Department of Planning and Permitting, City and County of Honolulu, "Primary Urban Center Development Plan," State of Hawaii, May 2004: 24–30., http://www.honolulu.gov/rep/site/ocs/roh/SCP_DP_PrimaryUrbanCenter.pdf.
[155] Ibid.
[156] Ibid.

areas around a rail station into walkable, mixed-use neighborhoods.[157] Therefore, sites that are within walking distance of the planned rail station are preferable. The TOD plan is to employ a ½-mile (2,600-foot) radius around each station to approximate a ten-minute walking distance. A ¼-mile (five-minute) walking distance is also defined to highlight the sites closest to the stations. The plan generally uses the ½-mile radius to address transportation improvements, urban design recommendations, and infrastructure needs. TOD is usually a mixed-used moderate to higher-density development that encourages walkability and the use of public transportation to reduce parking lots areas.[158]

5.3 Neighborhood Selection

According to the Kalihi TOD Development Plan the population around Kapalama, Kalihi and Middle Street is expected to increase by 34 percent by 2030.[159] The Kalihi TOD plan addresses land use, local transportation, economic, and infrastructure planning around all planed station for this predicted population grown. An inclusive amendment to Land Use Ordinance was adopted, by the city in 2008 to establish a framework for the development of the neighborhood TOD plans. It encourages public-private partnership when appropriate. The ordinance establishes that the TOD Plan should implement the objectives and policies of the Primary Urban Development Plan (PUC) Plan as well as community or master plans. To attain the plan goals, some amendments can be recommended by the TOD Plan to alter existing policies from the city; however, the TOD Plan should also respect and incorporate current polices.

After analyzing the TOD plan, I identified several neighborhoods in PUC area that will have increased land use density and are close to a planned rail station. Kalihi and Kapalama are

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[157] Department of Planning & Permitting, City and County of Honolulu, "Neighborhood TOD Plans: Kalihi," City and County of Honolulu, https://www.honolulu.gov/tod/neighborhood-tod-plans/dpp-tod-kalihi.html.
[158] Ibid.
[159] Ibid.

diverse residential and mixed-use neighborhoods. Both neighborhoods lack adequate green space for children to play. Children in other neighborhoods—within the PUC area—have easier access to the parks along the shore, which offsets the lack of green space in their neighborhoods. The shoreline in the Kalihi and Kapalama district is inaccessible due to industrial activities. ArcGIS was utilized to identify information about existing schools in the Kalihi and Kapalama neighborhoods that are located close to rail stations. In addition, existing parks were identified in order to understand the need for green spaces for children to play in these neighborhoods. See Figure 44.

Figure 44. Kalihi and Kapalama existing fabric education and parks close to future rail stations.

5.4 Selected Neighborhood–Kalihi

Even though, both of the Kalihi and Kapalama neighborhoods meet the site selection criteria and are in need of green spaces, Kalihi was identified as a neighborhood that embodied the site selection criteria the most because it has a major concentration of schools from pre-school to middle schools in a walking distance range to TOD station. Kalihi is composed of long-term residents and relatively recent immigrants to Hawaii. The area selected is primarily a residential neighborhood with small commercial and industrial businesses. See Figure 45.

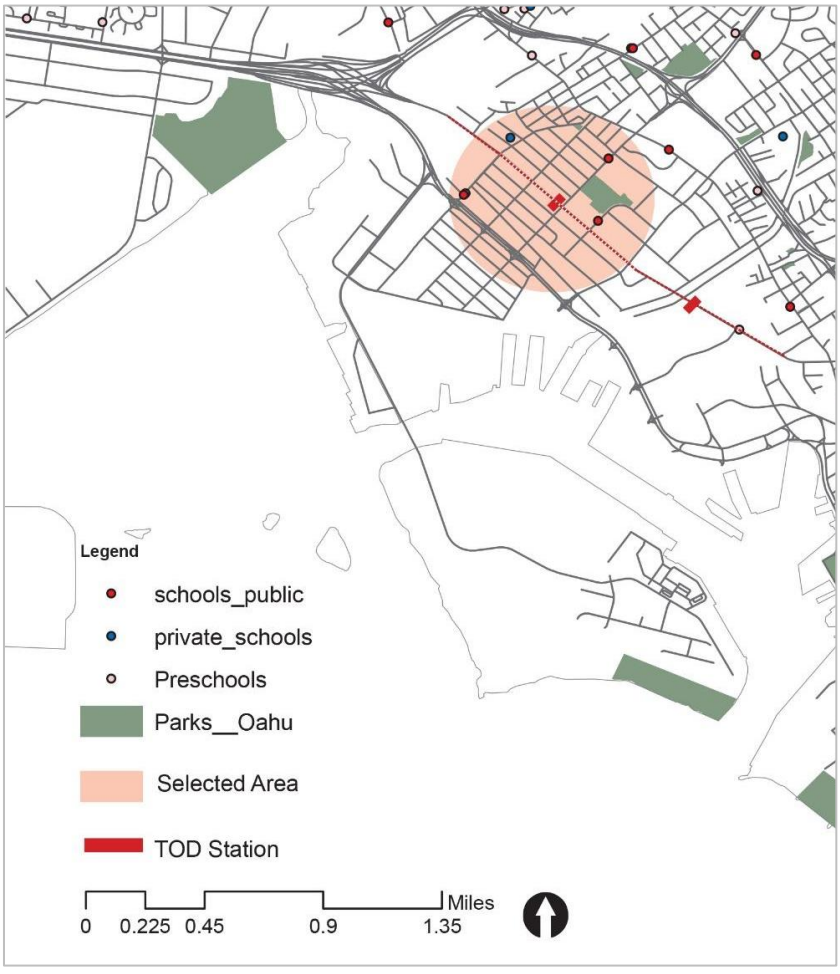


Figure 45. Kalihi Neighborhood Selected Area.

The selected area has schools from Kindergarten to 8th grade with a high number of children enrolled totaling 2,021. There is one middle school, Kalakaua Middle School, with an enrollment of 1,040; three elementary schools, St. Anthony with an enrollment of 92, Puuhale with 262 enrolled, and Kalihi Kai with 627, the latter including a small preschool. All schools are inside a quarter-miles radius of one another, which is considered a five-minute walking distance to Kalihi station. See Figure 46.

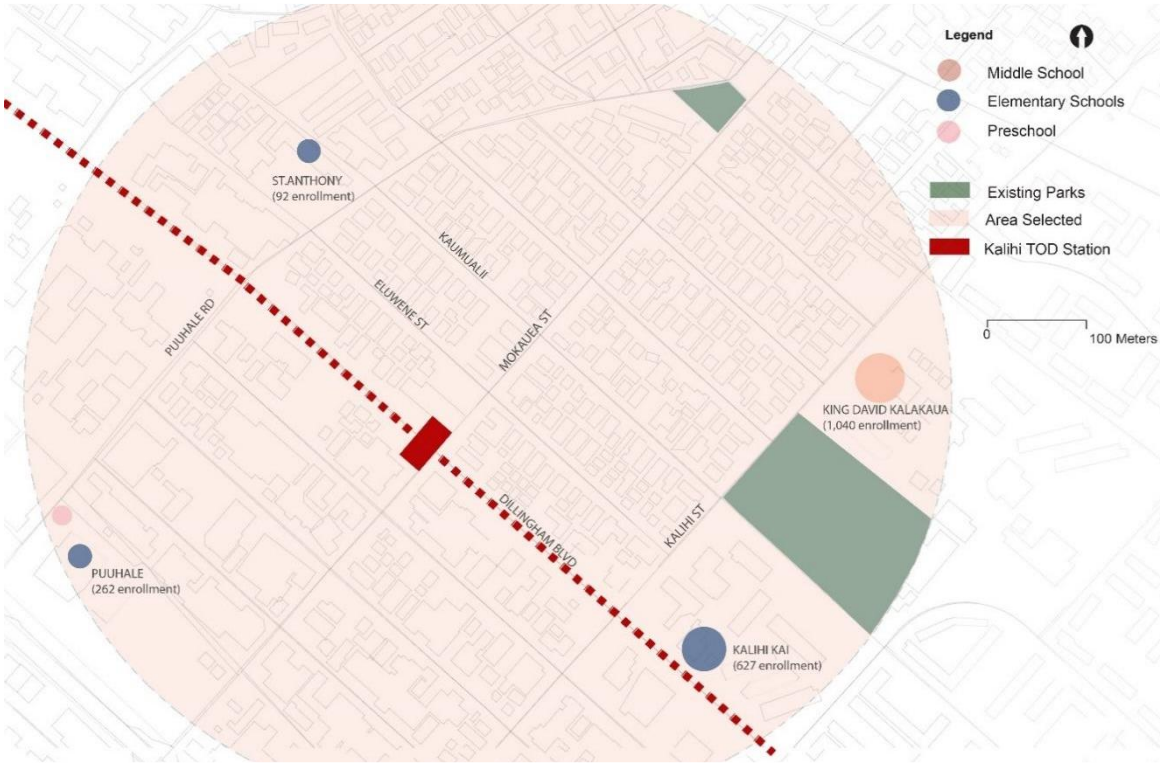


Figure 46. Kalihi Neighborhood Selected Area.

5.5 Existing Parks

The PUC DP recognizes Kalihi as one of the neighborhoods that lacks adequate park, recreation, and other open space facilities.[160] Parks and attractive green open spaces near the location of

[160] City and County of Honolulu. "Primary Urban Center Development Plan." 3–21.

the proposed Kalihi station are insufficient. Keehi Lagoon Park is a large park at 72 acres; however, it is not easily accessible from anywhere in the Kalihi corridor. Although there are two parks within the selected area, they do not provide the ideal spaces for children to play. The Kalakaua District Park, between Kalihi-Kai Elementary and Kalakaua Middle School, is an open grassy field that is mostly used by adjacent schools and by the larger community for sports activities. However, there exist no well-designed areas for children to play. The second park in the selected area, Mokauea Street Mini Park, is not well maintained, and there are few opportunities for children's play activities. Mokauea Street Mini Park used to have a playground, but, today, it basically consists of a basketball half-court of that is lacking in regular maintainance. The TOD Plan seeks to remedy these respective deficiencies and to increase the provisions and support to allow for increased safety and access to open spaces. The acquisition of significant additional park space is constrained by high real estate values and has a limited number of vacant parcels with favorable characteristics for recreation use and without disturbances to residential neighbors. (Unsupervised and unlighted parks can also attract crime and other problems associated with urban areas).

5.6 Vacant or Underutilized Opportunities

Defined by the City and County of Honolulu, potential development or "opportunity" sites are "those non-historic properties that are vacant or considered to be underutilized due to low building intensities or low building value relative to land value, or where buildings are vacant or in disrepair."[161] The Kalihi Neighborhood TOD Plan describes vacant lots and underutilized sites within the Kalihi neighborhood as offering great opportunities to meet the community needs by taking advantage of the access to rail and creating new spaces.[162] To identify some potential sites opportunities, the TOD Plan defined some methodologies to be applied to vacant or underutilized opportunities. Some examples are vacant sites or sites currently occupied by

[161] Department of Planning & Permitting, "Neighborhood TOD Plans: Kalihi."
[162] http://www.honolulu.gov/rep/site/dpptod/kalihi_docs/Kalihi_ExistingConditions.pdf.

surface parking lots and sites that are classified as “underutilized” because the building value is less than land value. Another example exists as low-intensity sites, where the floor area ratio (FAR) values are below 0.75 or 0.50. Other “Opportunity Sites” are classified as potential sites by stakeholders, landowners, or consultants.[163] In all of the examples mentioned here within this dissertation, site ownership must also be taken into consideration. Zoning code requirements and limitations, along with the knowledge of whether the site is municipally or privately owned, must be considered during the site-selection decision-making process.

The TOD plan for the Kalihi neighborhood, Google Earth spatial visualization, and a physical visit to the area were combined to identify available and underutilized opportunities in the selected area. See Figure 47.

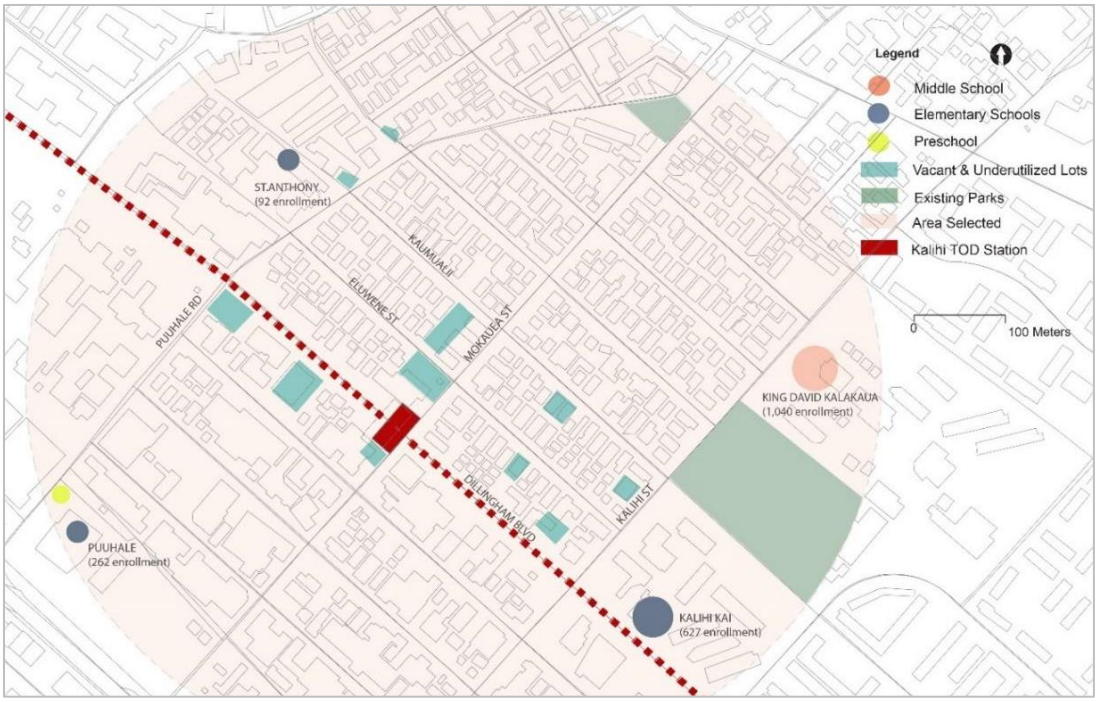


Figure 47. Vacant and Underutilized Opportunities in Kalihi Neighborhood.

[163] http://www.honolulu.gov/rep/site/dpptod/kalihi_docs/Kalihi_ExistingConditions.pdf.

Land in the TOD planning area is owned mainly by public agencies (City, State, and Federal) and Kamehameha Schools. Public agencies include the University of Hawaii–Honolulu Community College campus, the Oahu Community Correctional Center, and the Hawaii Department of Transportation's ownership of most of the port lands. The Fort Shafter military base is located Ewa of Middle Street. Kamehameha Schools is the largest private landowner in the state of Hawaii. However, most of the small residential and industrial properties within a ¼ mile of Kalihi station have individual private owners. The vacant and underutilized areas identified on the map above are predominant privately owned.[164] After analyzing the area, four potential sites that meet the site selection criteria the most were selected. See Figure 48

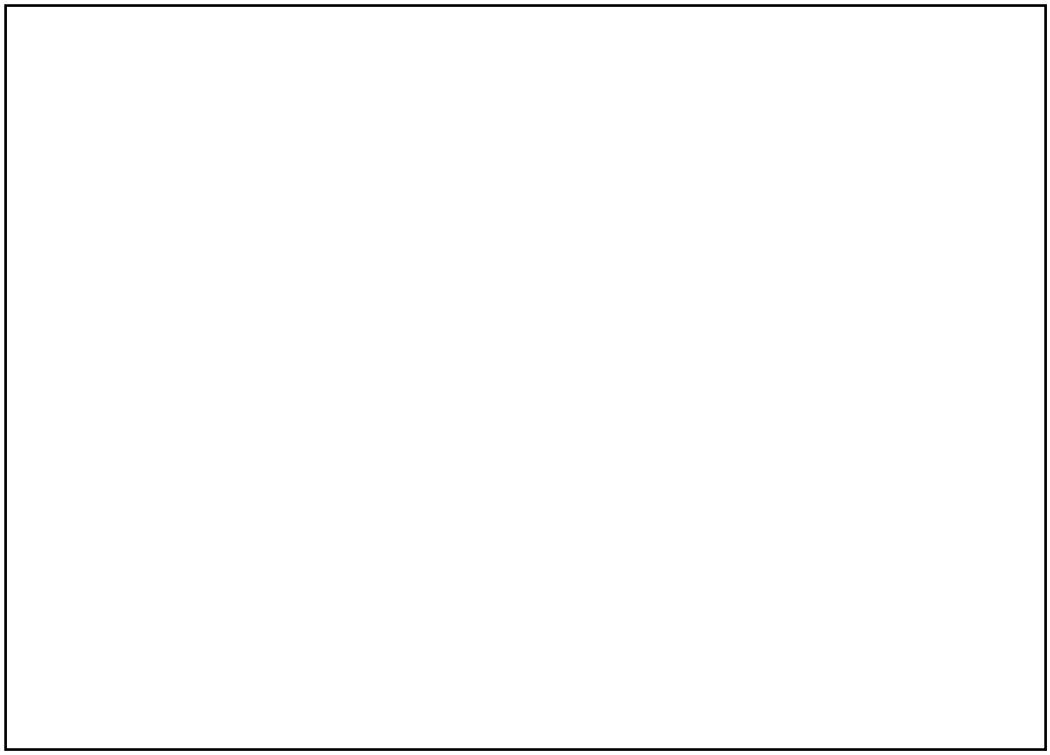


Figure 48. Potential Site Opportunities in Kalihi area. (Found using https://www.google.com/maps).

[164] http://www.honolulu.gov/rep/site/dpptod/kalihi_docs/Kalihi_ExistingConditions.pdf.

Site 1 is a 4,650-square-feet, private, vacant lot, located at 1804 Dillingham Boulevard in a zoning considered BMX-3 Community Business District. This is the closest site to the proposed rail station. It exists as a likely walking route between the rail, schools, housing, and general community services. The drawback to this site is that it is located on a commercial property adjacent to a noisy and busy arterial road that is not the ideal location for a playground. See Figure 49 and Figure 50.

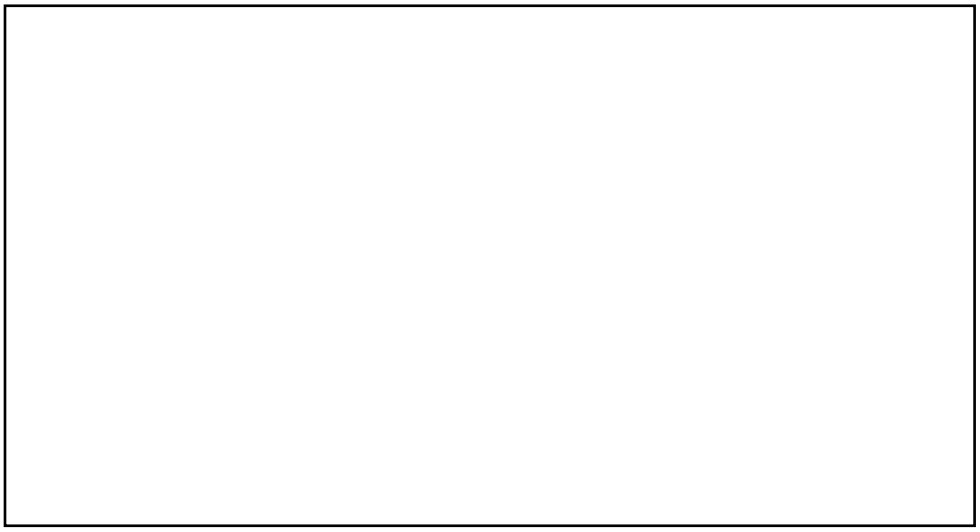


Figure 49. Site 1 view. (Found using https://www.google.com/maps).

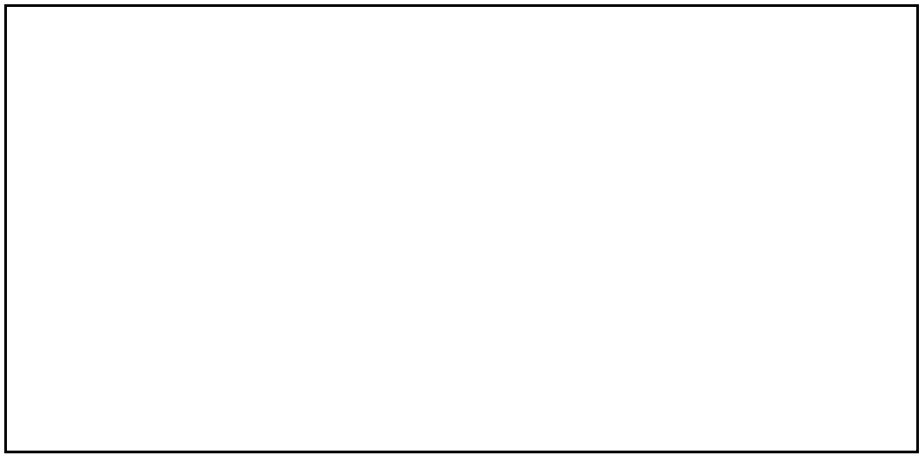


Figure 50. Site 1 view. (Found using https://www.google.com/maps).

Site 2 lies adjacent to a small lane (Wilcox Lane) in an industrial mixed-use (IMX-1) area between Gulick Avenue and Kopke Street close to schools. See Figure 51 and Figure 52. There is a 1,892-square-feet, privately owned vacant lot on one side (2028 Wilcox Lane) and a grassy area on the other in front of an apartment building, which could possibly connect easily to the playground. The drawback for this site is that it is to close to the industrial activities and is largely outside of residential areas.

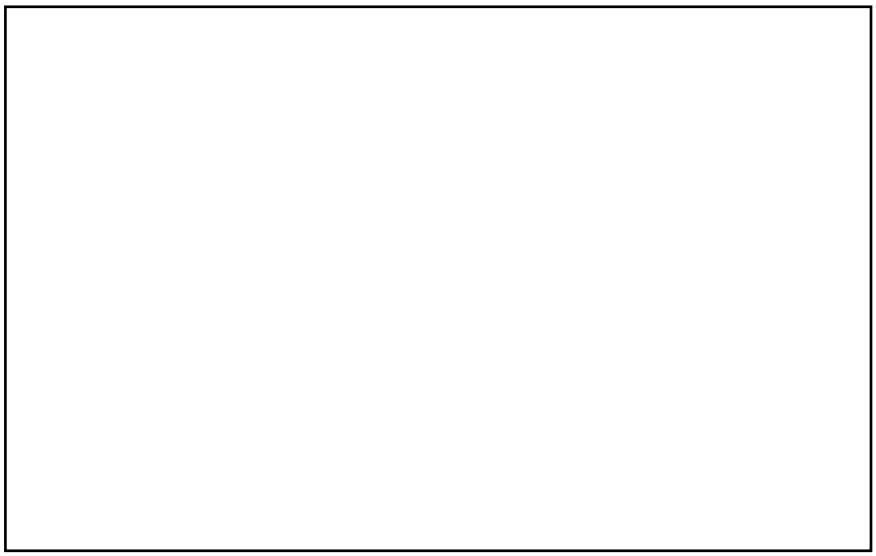


Figure 51. Site 2 view. (Found using https://www.google.com/maps).

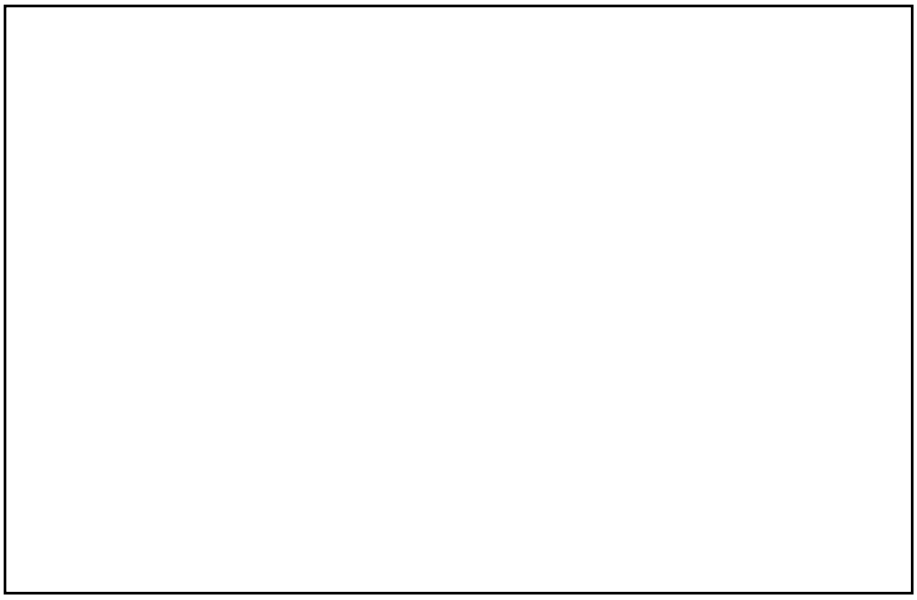


Figure 52. Site 2. (Found using https://www.google.com/maps).

Site 3 stands as a 2,503-square-feet, privately owned, vacant lot at 736 Puuhale Road in an industrial mixed-use (IMX-1) area close to a school. This location is in between the proposed rail station and the commercial areas on North King Street. The drawback to this site is that it has a dual-party wall with residential units, and the construction of a playground might cause disturbances to residential neighbors. In addition, the lot is close to industrial activities that might bring disturbances to those within the potential playground area. See Figure 53 and Figure 54.

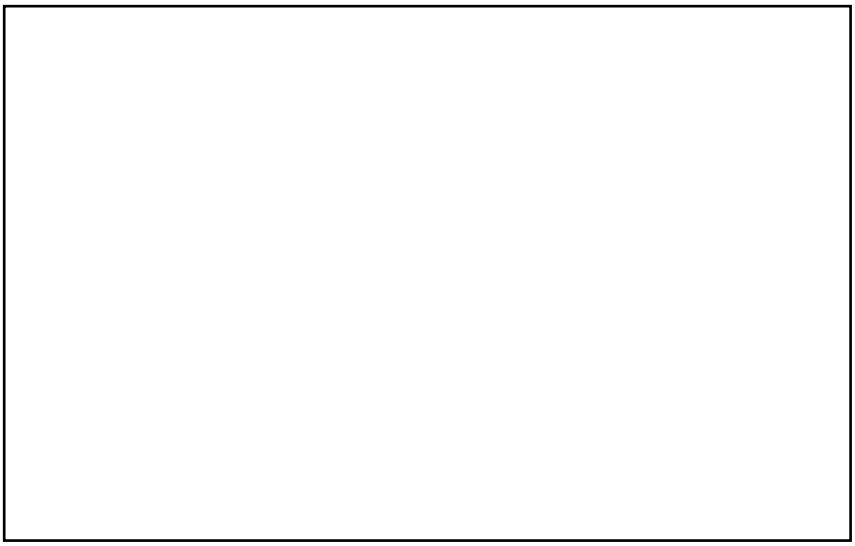


Figure 53. Site 3 view. (Found using https://www.google.com/maps).

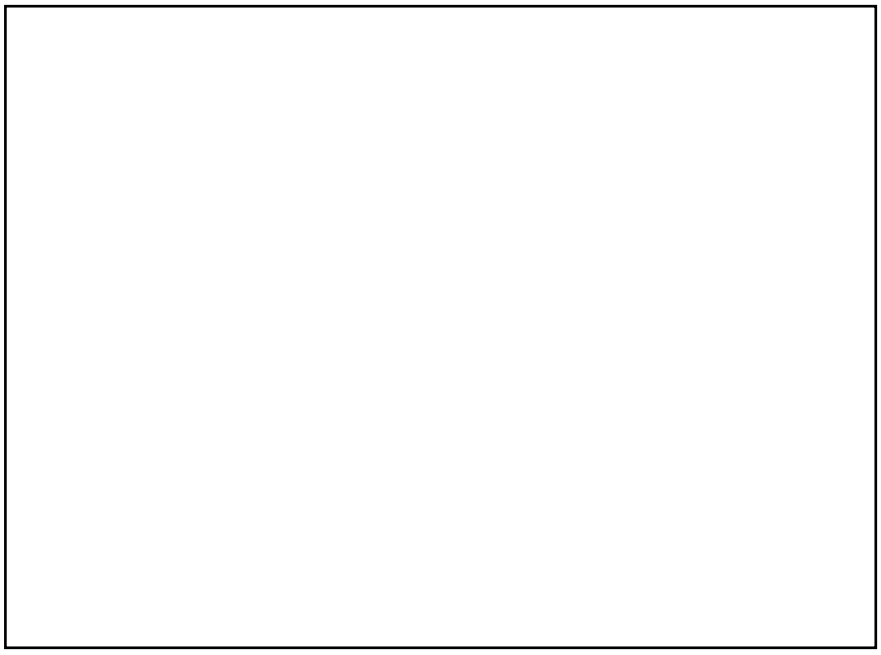


Figure 54. Site 3 view. (Found using https://www.google.com/maps).

The site selected, site 4, is a General Preservation P-2 zoning designation adjacent to a residential and mixed-use neighborhood. It is five minutes or less walking distance to all neighborhood schools and also to the Kalihi TOD station. This site was selected as it follows the site criteria selection most adequately. It is comprised of two lots—one with 6,292 square feet and one with 7,463 square feet (which is in accordance with the minimum square footage of 3 acres for the zoning of a playground), and both lots are owned by the City and County of Honolulu. The area stands between two corridors (Mokauea Street and Puuhale Road) that connect to both residential and commercial areas. As such, the area is optimal for a playground site because it is already designated as a park but, as of September of 2017, it is in need of revitalization. It consists of mostly empty space with a poorly maintained half basketball court and a concrete pad where playground equipment previously existed. See Figure 55 and Figure 56.

Figure 55. Site 04–Mokauea Street Mini Park. (Found using https://www.google.com/maps).

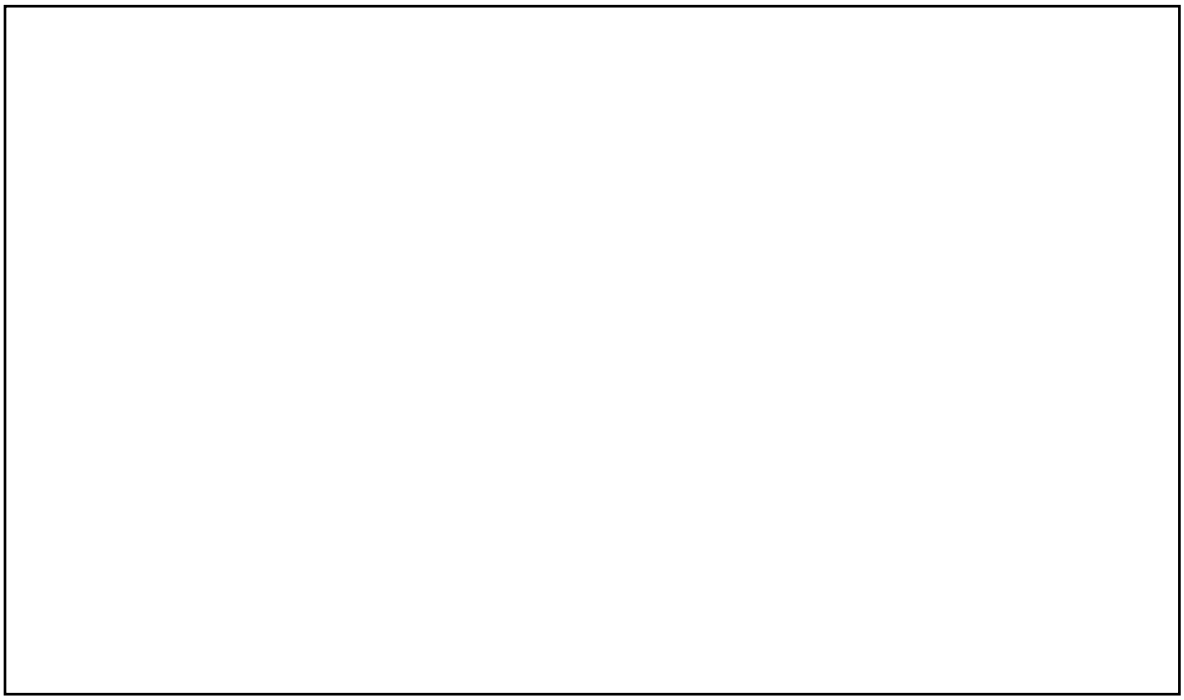


Figure 56. Site 04–Mokauea Street Mini Park. (Found using https://www.google.com/maps).

5.7 Ownership of Selected Site

The decision to select Site 4 for this project was influenced by on the land's ownership. When selecting a privately owned site, a major condition to its development is the owner's interest. If it would not benefit the owner of the land and if it presents any deficit for that entity, site development can be problematic. Another possible drawback of selecting a privately owned site is that it could discourage municipal funding, which is often essential for areas where the safety of children is a concern. Although all four sites previously selected meet the site selection criteria, three of them are privately owned. The exception is the selected site that lies under municipal ownership. This site is also currently designated as a recreation area. Even though Mokauea Street Mini Park is not classified as a vacant or underutilized lot by the TOD Plan, it is in alignment with the pre-established criteria as a mini park that needs revitalization. Thus its revitalization and development would be encouraged, especially since the surrounding area is municipally recognized as lacking green spaces and actively used recreation areas. The selected site is also more likely to be eligible for government funding than the other privately owned sites as zoning restrictions would be more readily accommodated.

6 Chapter 6. Site Selection

"The TOD Zone is the area where special district regulations will apply. Although the TOD Zone highlights the sites that are most likely to redevelop in response to rail transit access, it is also possible that sites beyond this area could also redevelop as TODs."[165] Mokauea Street Mini Park will be impacted by the TOD Plan because it is within ¼ mile of a rail station. Information for the site analysis is based on a predicted TOD Plan for Kalihi neighborhood.

6.1 Site Overview

Mokauea Street Mini Park is a 13,000 square foot mini park located on 834 Mokauea Street in Honolulu, Hawaii 96819 in the area known as Kalihi. It is zoned as a General Preservation District (P-2), which designates open space or recreation land that provides outdoor space for the public's use and enjoyment within the city's built environment. It is within Residential (R-5) neighborhood and is adjacent to industrial Mixed use (IMX-I) and Community Business Mixed Use (BMX-3). The zoning height limitation for the Mokauea Street Mini Park is less than or equal than 30 feet. For the adjacencies on the Mokauea Street the zoning building height is from 30 feet to 60 feet. For the Puuhale Road, it is from 60 feet to more than 150 feet. According to TOD Plan, building height will remain fairly low in the Kalihi areas adjacent to Mokauea Street Mini Park. Parking requirement for this area will be consistent with existing regulations for uses permitted in base zoning district (P-2).

6.2 Street Network

The Transit Oriented Development plan aims to improve the quality of public spaces by integrating the rail station with the surrounding community. It promotes bicycle travel and aims to

[165] https://www.honolulu.gov/rep/site/dpptod/kalihi_docs/Kalihi-TOD-Plan_CD1_FD1.Final_web.pdf.11-7.

improve streetscapes and sidewalks to create a better walking neighborhood. The selected site is located in between two collector streets, Mokauea Street and Puuhale Street, thus allowing easy access and protection against the intense traffic of the arterial roads, Dillingham Road and North King Street. The proposed bike lane on Mokauea Street will facilitate access to a possible playground. See Figure 57.

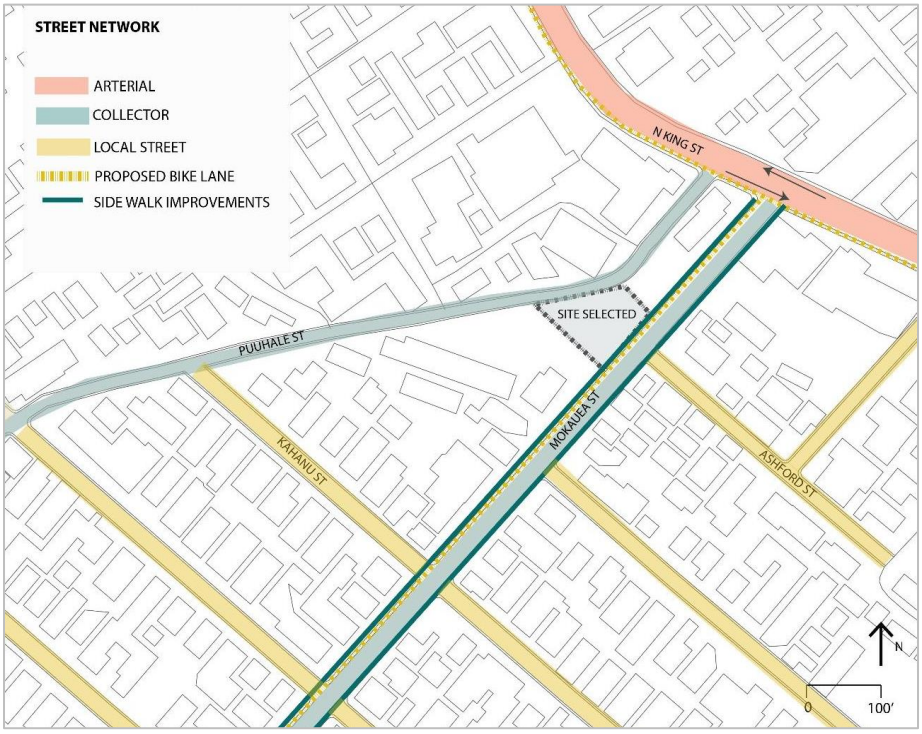


Figure 57. Street Network.

The TOD Plan includes sidewalk improvements by creating wide and comfortable pedestrian spaces that allow people to comfortably walk to enhance safety and accessibility. According to the TOD Plan, Mokauea Street will be designated as a Green Street, which will provide a safe walking environment for the pedestrians with trees on both sides of the street.[166] Green Streets

[166] DPP, City and County of Honolulu, "Neighborhood Tod Plans: Kalihi."

might connect existing and planned open spaces to create a space network and improve walkability and livability. See Figure 58.

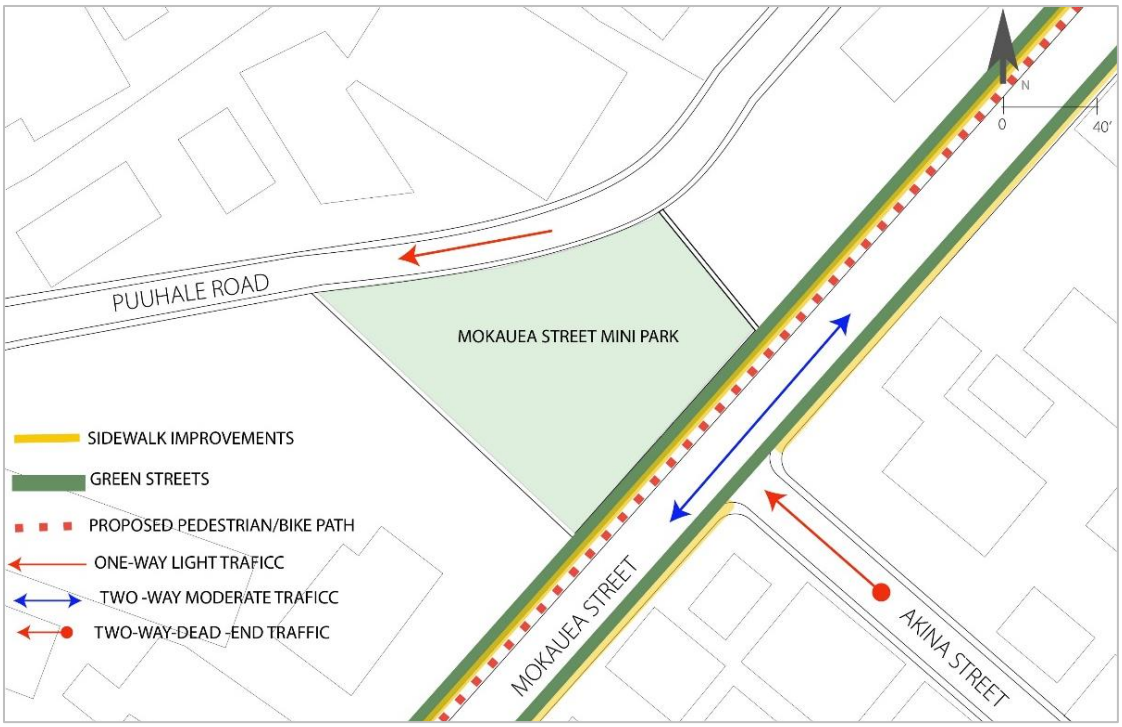


Figure 58. Existing Land Use.

Sidewalks will be wide and separated from street landscaping and street furniture areas. The areas close to the curbs will be designed for street trees, landscaping, street lights, bus stops, street signs, trash/recycle bins, bicycle parking, street furniture, and newspaper boxes. According to the TOD Plan, open spaces that adjoin streets should be provided with seating and shade along edges to emphasize visibility and facilitate access.[167] To address the site selection criteria, the chosen site is located in a predominantly residential area with service and commercial activities on its perimeter. It will allow children to walk between schools, community services, and

[167] DPP, City and County of Honolulu, "Neighborhood Tod Plans: Kalihi."

the residential area while avoiding busy traffic. This chosen location, thus, limits children's exposure to automobiles, air pollution, noise, and other safety concerns. See Figure 59.

Figure 59. Existing Land Use.

The scale and character of land use around the Kalihi station will be largely maintained with a mix of industrial and commercial uses makai (oceanside) of the station and primarily residential uses mauka (mountainside) of the station. Areas adjacent to Mokauea Street Mini Park will be predominant residential and mixed use. See Figure 60.

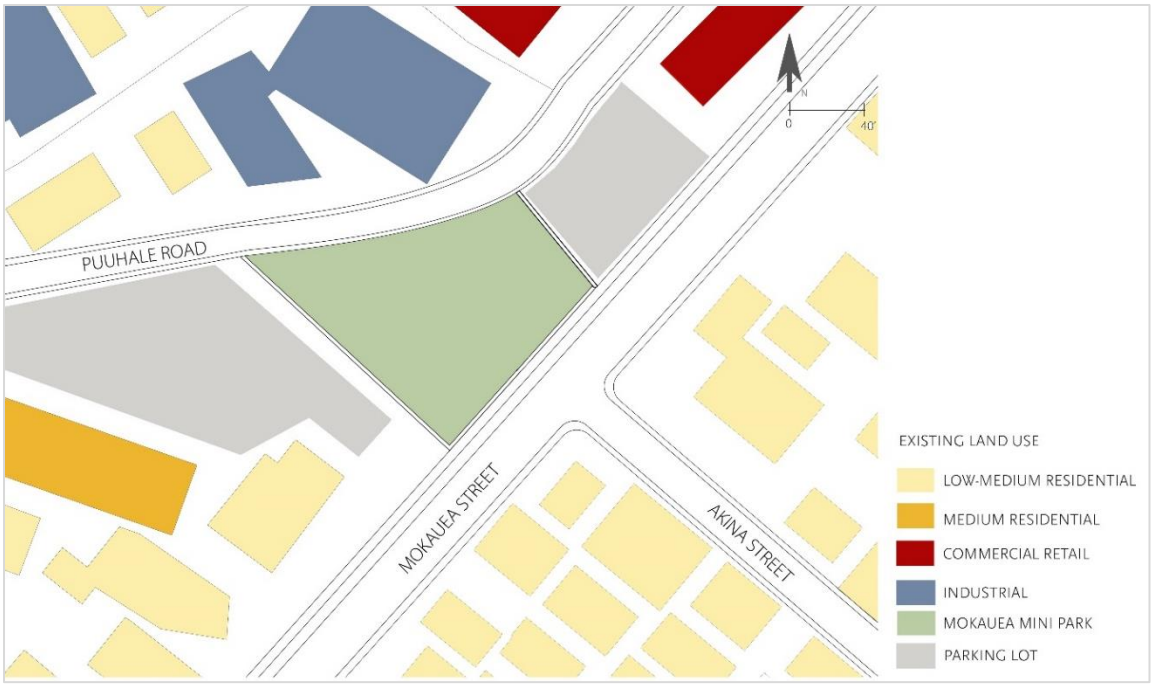


Figure 60. Adjacent Areas to Mokauea Street Mini Park.

6.3 Shade Analyses

The figures below demonstrate the shade projection over the playground areas during the summer (June 21st) and winter (December 21st) solstice. The buildings height is defined according to the TOD building height prevision and it demonstrates that the adjacent buildings will not have a main impact in over-shading the site. See Figure 61, Figure 62, Figure 63 and Figure 64.

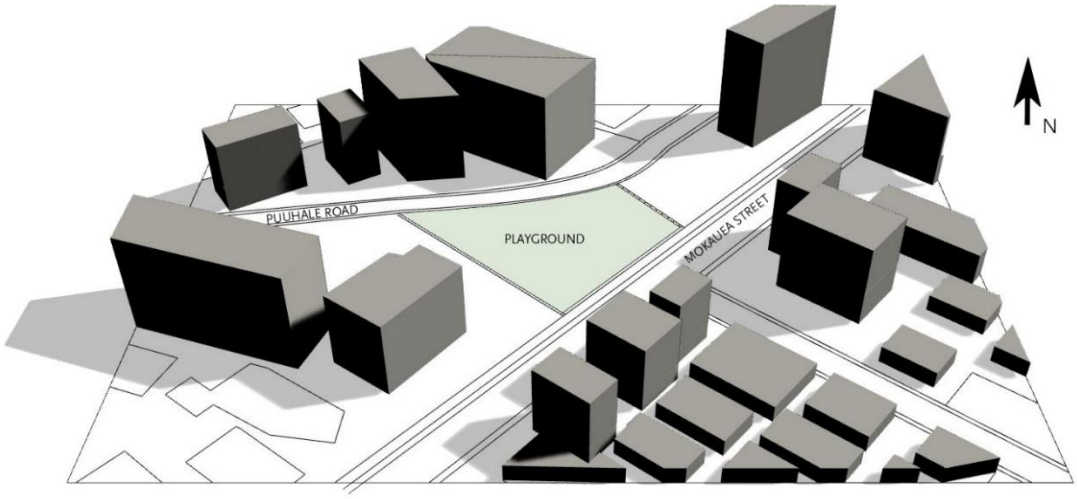


Figure 61. Shadow Study–Summer Solstice 10:00 a.m.

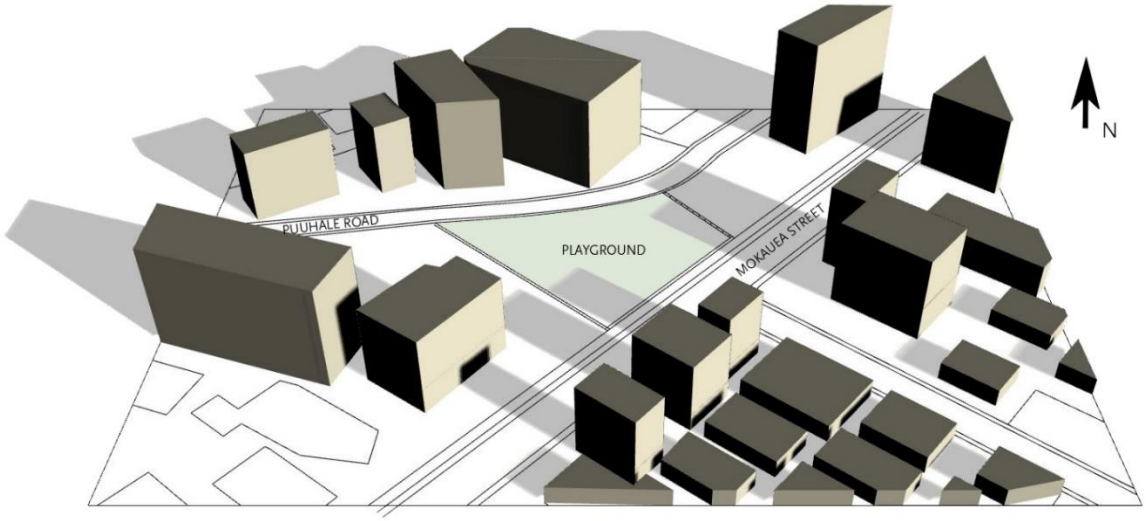


Figure 62. Shadow Study–Winter Solstice 10:00 a.m.

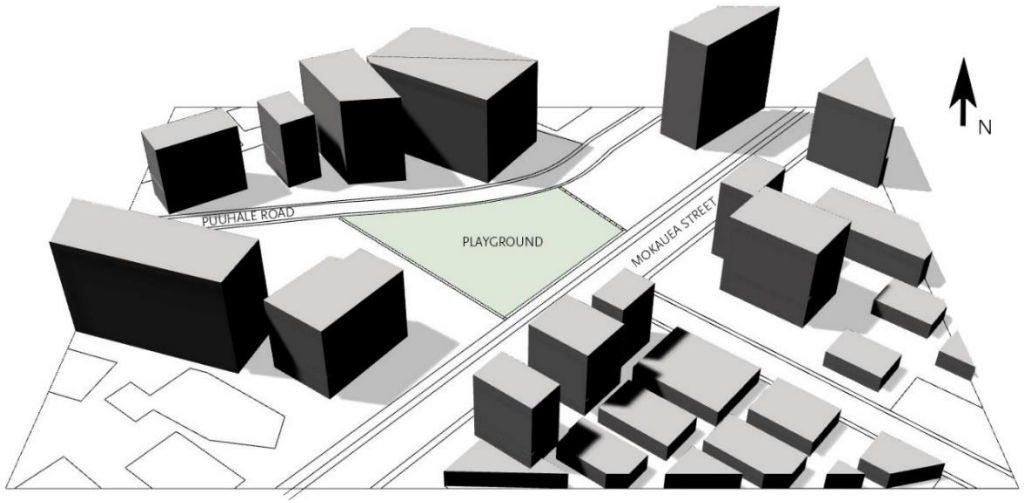


Figure 64. Shadow Study Diagram–Summer Solstice at 4:00 p.m.

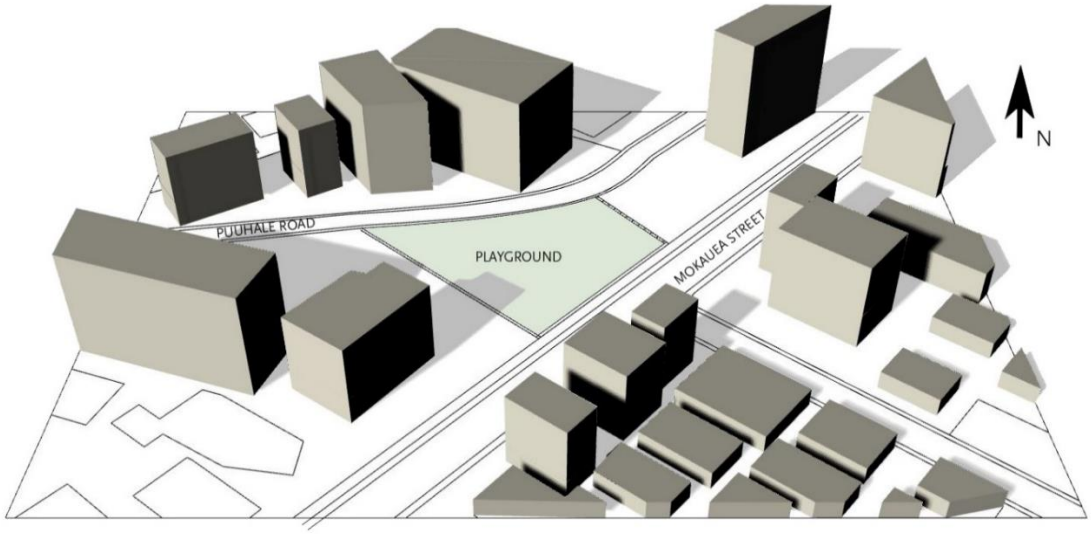


Figure 15. Shadow Study Diagram–Winter Solstice 4:00 p.m.

6.4 Climate

The trade winds of Honolulu blow from the northeast direction, bringing an enjoyably brisk and refreshingly cool breeze inland. Coming from the opposite side, the southwest, Kona winds bring warm and humid conditions to Hawaii. The playground should be designed to allow the trade

winds to travel across the site to create an enjoyable breeze and a comfortable environment. A barrier will be provided to protect the playground areas from Kona winds that blow from the southwest. See Figure 66.

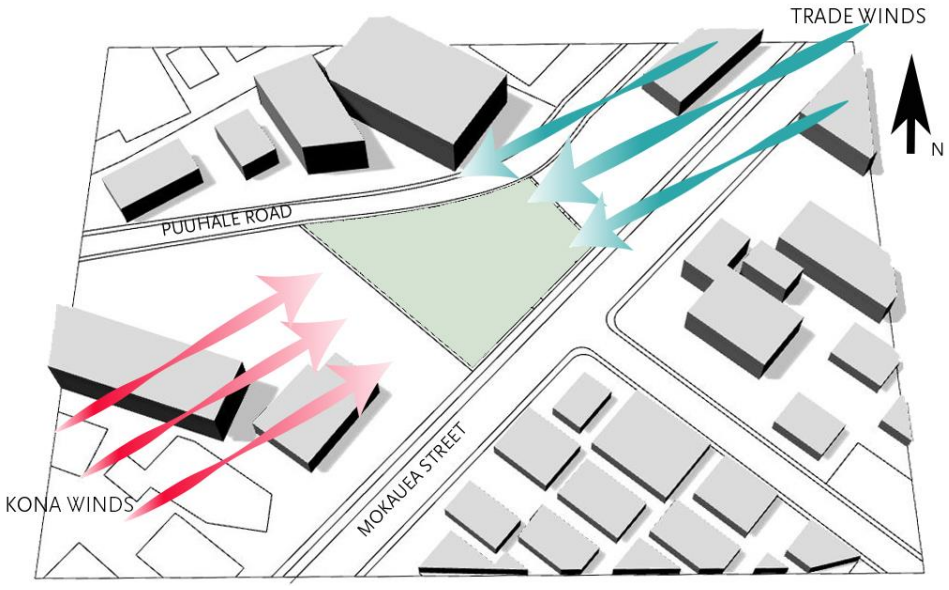


Figure 66. Windy Analyses Diagram.

6.5 Design Strategies

The perimeter of the playground should provide protection against external factors, thus creating a pleasant and comfortable environment for children and caregivers. To protect against Kona winds, an adjacent 8-feet-high wall will be designed on the southwest side of the site. This wall also will help to protect the adjacent residential area from possible excessive noise from the playground. On the northeast side a 6-feet-high wall will protect the playground area from strong gusty winds while allowing the trade winds to pass through the site to create a pleasant breeze throughout the playground area. Since Mokauea Street will be designed as a Green Street, the main entrance and exit of the playground will be located on Mokauea Street. As such, the entrance will be integrated with a Green Street to facilitate easy access to the playground. A

secondary entrance and exit will be located on the west side, adjacent to Puuhale Road. See Figure 67.

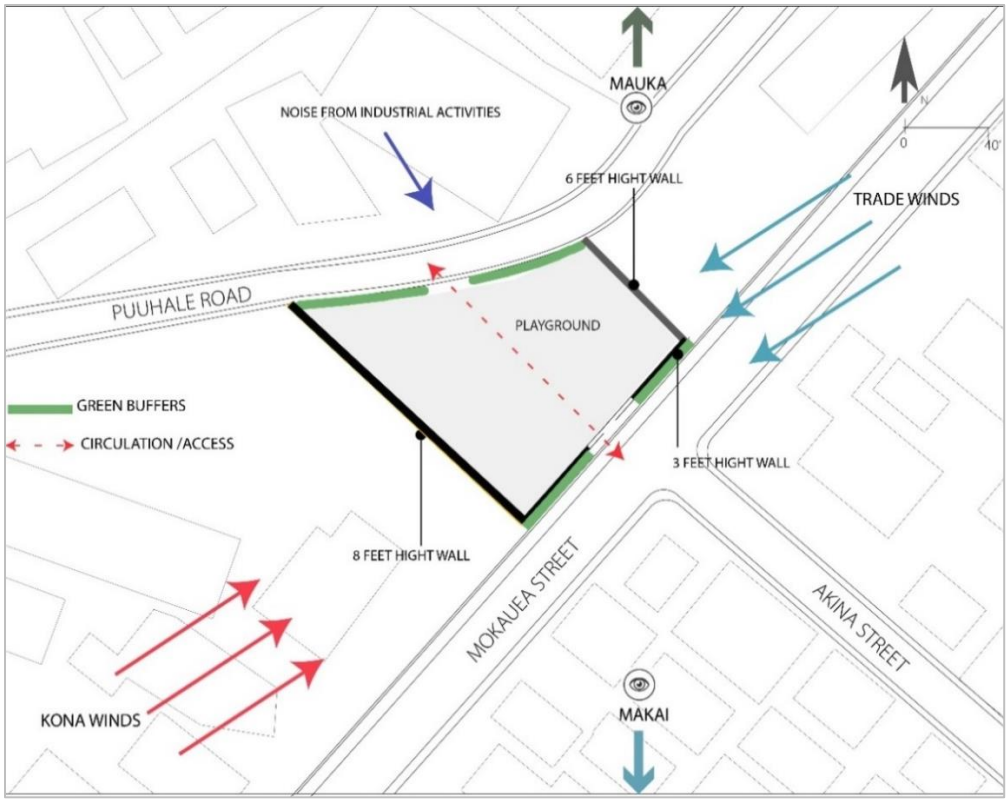


Figure 67. Playground Perimeter and Adjacencies.

Sun exposure should be controlled in play areas to avoid excessive heat on equipment and excessive sun exposure on children. Most playground areas will not be shaded by adjacent buildings in the hottest part of the day. Therefore, trees will be strategically located to allow the incidence of morning sun and to provide shades to protect from the afternoon sun. Large canopy trees will be positioned in spaces were parents and caregivers will be seated to provide shade. Small trees will be integrated with play elements as part of the biophilic principle of “Connection with Natural Systems” and “Visual Connection with Nature.” Vegetation as a green buffer will protect playground areas againts the noise from industrial activities that could come from the

industrial warehouses on Puuhale Road. Noise buffers can be natural landscaping such as trees, shrubs, vines, or livings walls. See figure 68.

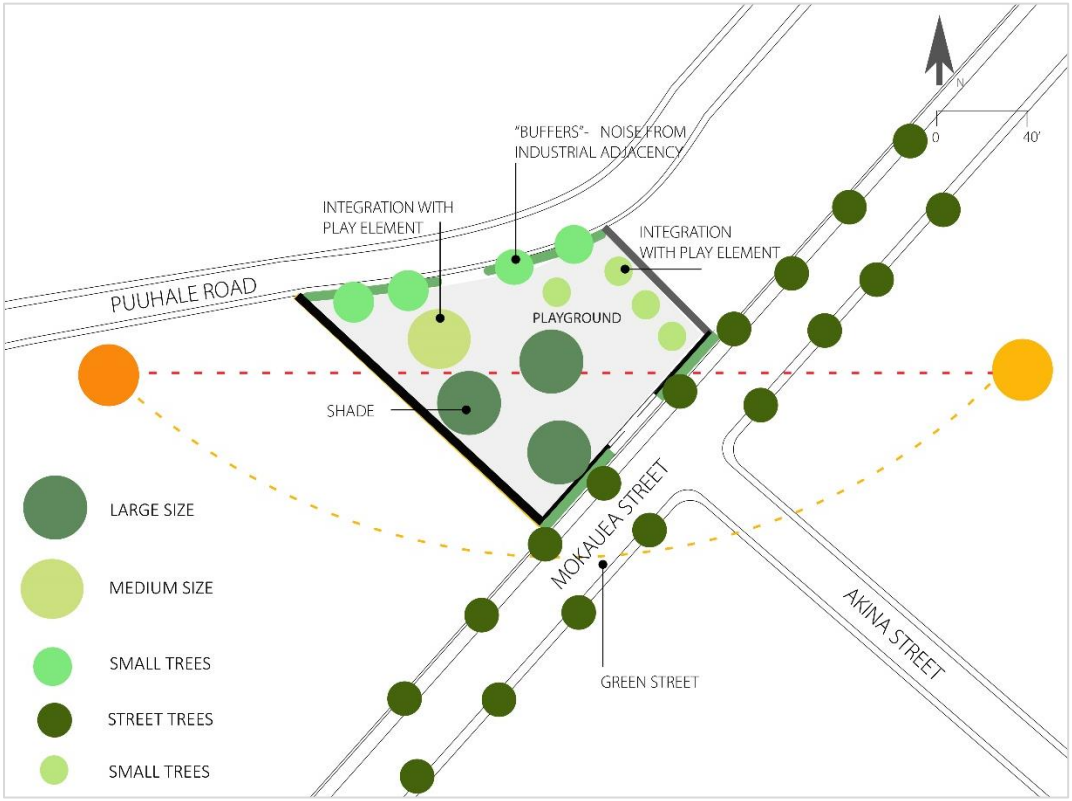


Figure 68. Landscape Strategy

7 Chapter 7. Design

7.1 Design Concept

For the conceptual design of the playground, I was inspired by a tale called "Buddha's Story of a Butterfly." The story is described as follows:

> A man found a pupa of a butterfly. One day a small opening appeared. He sat and watched the butterfly for several hours as it struggled to squeeze its body through the tiny hole. Then it stopped, as if it couldn't go further. So the man decided to help the butterfly. He took a pair of scissors and snipped off the remaining bits of cocoon. The butterfly

> emerged easily but it had a swollen body and shriveled wings. The man continued to watch it, expecting that any minute the wings would enlarge and expand enough to support the body. Neither happened! In fact, the butterfly spent the rest of its life crawling around. It was never able to fly. What the man in his kindness and haste did not understand: The restricting Cocoon and the struggle required by the butterfly to get through the opening was a way of forcing the fluid from the body into the wings so that it would be ready for flight once that was achieved. Sometimes, struggles are exactly what we need in our lives. Going through life with no obstacles would cripple us. We will not be as strong as we could have been and we would never happily fly.[168]

This story can be considered as a metaphor to demonstrate that parental over-protection has been responsible for a detrimental effect regarding children's overall development. In addition, the analogy within this tale is in relation to the way that children are being overprotected by playground design and playground rules based primarily on safety and, thus, are applied within the design of playgrounds. As such, contemporary playground design has the potential to affect children's natural needs and overall development. Accordingly, the majority of U.S. playgrounds today exist as colorful, plastic, manufactured equipment that has been designed with safety concern as the primary guidelines.

Playgrounds used to be designed for children with a purpose of stimulating their overall development and enticing them toward daily play. The ideal situation for creating wise and confident young people can best be accomplished by allowing them to break out of metaphoric "cocoons" by themselves so as to become strong to be able to mature without too much external interference during times of play. Playground equipment and structures that are designed based on safety concerns as primary criteria often override opportunities for architects and urban planners to explore the potential that a playground could offer for overall child development. Thus, my goal is to apply the concepts of biophilic design within the design of playgrounds to

[168] http://wisdomquarterly.blogspot.com/2009/10/butterfly-and-buddha.html

establish a connection with nature in a playground environment so it will be beneficial to children's physical, psychological, and emotional development and, thus, overall health. Again, to extend the butterfly metaphor, in order to grow into an adult butterfly, one must go through four stages: egg, larva (caterpillar), pupa (chrysalis) and adult. See Figure 69.

Figure 69. Butterfly Life Cycle.

As is true for the metamorphoses of a butterfly, children of different ages experience specific stages of development accordingly, and every phase is associated with distinct needs and abilities. Thus, I have adopted the life cycle of the butterfly as a metaphor for a child's overall development and propose that the life of a butterfly be used as an inspiration for the design of an ideal contemporary playground. Therefore, each area of a playground should be designed with respect for the gradual and overall development (physical, psychological, emotional, and social) of children and should offer the appropriate challenges and attractiveness when it comes to playground play.

The CPSC handbook defines that toddlers are children from 6 months through 23 months of age, preschool-age are children from 2 years through 5 years of age, and school-age children are from 5 years through 12 years of age. Throughout the research for this dissertation, I have adopted the age classification that is defined by CPSC handbook, and I have created analogies for each age group so as to align each one to each stage of the butterfly life cycle. I have proposed to divide an ideal playground into distinct areas, each of them analogously classified accordingly to the stages of butterfly development. For each of these spaces, I have identified words that are related to each phase of butterfly development and have used each term to guide me regarding the application of the biophilic design principles within playground. See Figure 70.

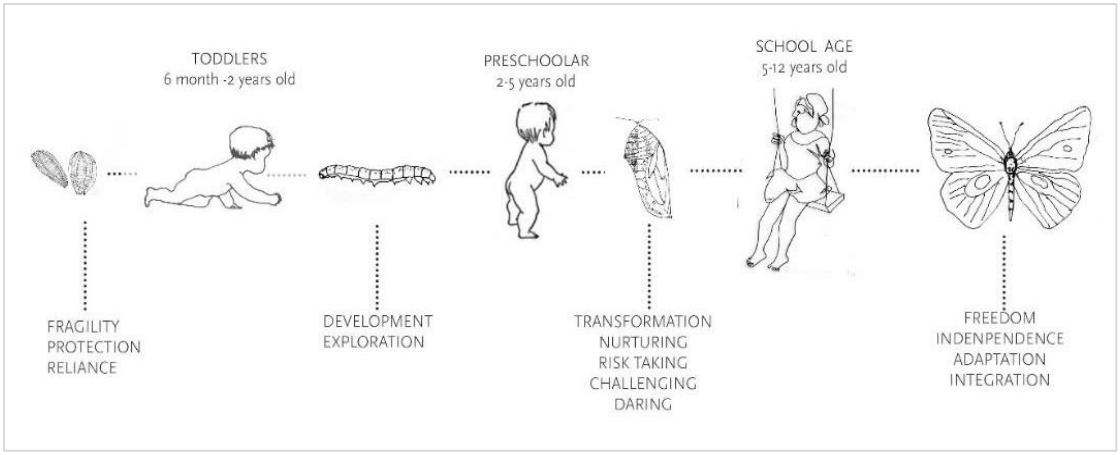


Figure 70. Children and Butterfly Stages of Development.

The first stage of butterfly development is the egg phase. Making the analogy with children's development, it represents the toddler's phase and will vary from 6 months through 23 months of age when children need more assistance and are more dependent on caregivers. The words best connected to this phase are fragility, protection, and reliance.

The second stage of the butterfly life cycle is when it becomes a caterpillar. This stage is analogously represented as the preschooler phase, which is from 2 to 5 years old. It is when

children start to be more independent from their parents. The words that best define this phase are development and exploration.

The third stage of the butterfly life cycle is the chrysalis. It is represented as an overlapping space on the playground (Cocoon), where children with overlapping ages can play together. This space is best located between caterpillar and butterfly areas. Acknowledging the analogy with the "Buddha's Story of Butterfly," this space is one in which children can break out of the metaphorical cocoon by themselves. The words that best define this phase are transformation, nurturing, risk taking, challenging, and daring.

The fourth and last stage of the butterfly life cycle is that of actually becoming the butterfly. This phase is analogously represented as a school-age (children from 5 to 12 years old) phase for developing children. The words that I have established to define this phase are freedom, independence, adaptation, and integration. Since all beings' development exists as a process that occurs gradually, an innate overlapping of spaces upon a playground, in regards to design, exists in such that the respective space will be designed considering the mutual overlapping within children's natural development.

The following diagram depicts the application of the concept described above. To apply this concept on a design of a playground, the playground will be divided into three areas with an overlaping area (Cocoon). See Figure 71.

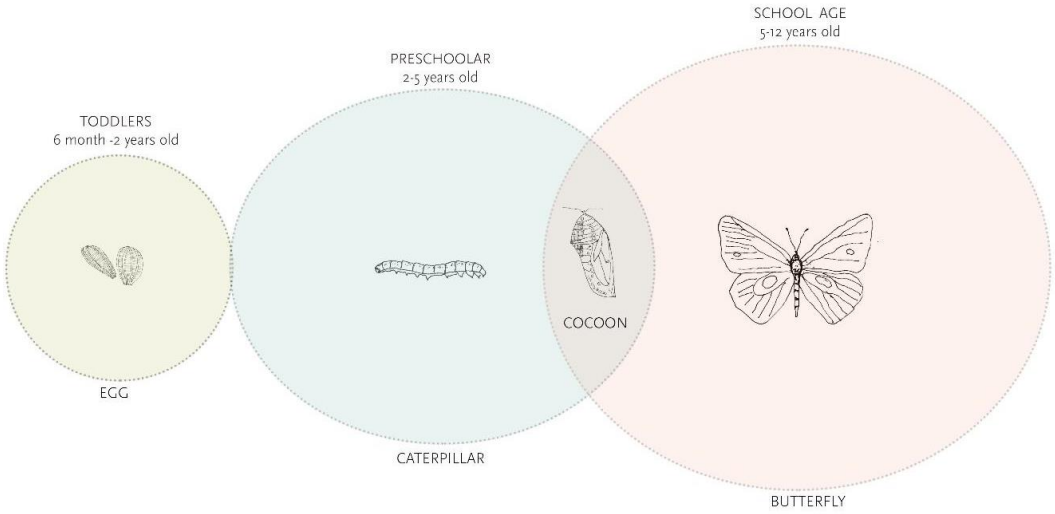


Figure 71. Playground Areas.

7.2 Biophilic Design Strategy

By establishing biophilic design principles as the foundation for this dissertation regarding the creation of engaging contemporary playgrounds, the specific design strategy is to propose a way to create site-specific playgrounds with play elements that are wholly integrated with nature. Essentially, the site and all play elements should be designed to incorporate biophilic principles so as to create an ideal space for children to play while in contact with nature and, as such, in an environment that will contribute for their overall physical, emotional, and psychological development. The topography of a given site is considered within my proposed as it can be manipulated to create spaces that enhance the application of a biophilic design principle of prospect and risk/peril. Variation in topography stimulates creative play by allowing the incorporation of spaces for climbing, sliding, and rolling around, among other activities.

The attributes and patterns of “Nature in the Space” and “Direct Experience of Nature” will be substantiated as ideal for children when applied to the overall site design and landscape of a

respective playground. For example, using natural materials like wood, stone, sand, and water features allow children to be in more direct contact with natural elements. Since a playground is generally an outdoor space, dynamic and diffuse light principle will be more efficient if applied within the design of play elements, where light and shadow can be experiment with in a variety of ways. For example the openings within playground structures and natural elements could allow sunlight to reach inside from multiple angles. Visual and non-visual connections with nature can be better explored through materials used to create playground structures—the inclusion of plants and trees, specific shapes of included objects, and other nature-based elements that allow for the application of biophilic design throughout the entire creation of a respective playground.

Regarding the playground's overall layout design, spaces that encourage sensorial stimuli such as auditory, haptic, olfactory, or gustatory can offer opportunities to apply the "Non-Visual Connection with Nature" pattern features that promote the noise from water or wind, texture that evokes natural elements, and plants that exude fragrance or that are even edible. The application of "Connection with Natural System" can be explored within the playground's site design through the inclusion of natural processes, for example a rain garden and seasonal deciduous plants. The "Biomorphic Forms and Patterns" that are related to the "Natural Analogues" category can be adopted within all elements of the playground as well as on the overall layout within a given site.

The application of organic shapes and patterns within a playground's design provides association with configuration that occur in nature allowing playground users to make easy and consistent connection to nature. Right angles and straight lines are not natural phenomena; therefore, they should be avoided within the biophilic playground design. In addition, within the "Natural Analogues" category, the pattern of "Material Connection with Nature" can be employed by incorporating design materials and structural elements that reflect the local ecology and geology (e.g. the use of native vegetation and locally found stones within the Hawaiian Islands such as lava rock).

The attribute of “Images of Nature” could be represented within playground design as sculptures of animals. Similarly to “Natural Analogues” category, the “Indirect Experience of Nature” also encourages the use of natural shapes and forms and natural materials and colors. According to Kellert and Calabrese, the application of “muted earth tones” are the most effective to obtain a biophilic response, since they occur most commonly in nature, and the use of bright and vibrant colors should be avoided.[169] A natural color pallet is preferred when defining playground elements such as structural equipment and landscape design. A color scheme can also be used as a wayfinding strategy and be defined to delimitate play areas and equipment according to appropriate age.

Regarding the last category, “Nature of the Space,” the application of a biophilic design patterns in the terms of “Prospect” can be applied on a sloped terrain that allows some higher points within the topography, as well as within play elements that allow views from elevated spaces. “Refuge” is defined as enclosed spaces where the individual has overhead and rear protection, thus creating spaces that provide a sense of safety and security. Refuge-based spaces can be applied within play elements or within the landscape design. For safety and surveillance concerns, all refuge types of spaces should have openings that allow a view to the inside. Strategies to create a mysterious atmosphere are described as a “partially revealed” spaces.[170] A “Mystery” pattern can be applied within the design of play elements in which the abstraction will leave room for imagination, and the unrevealed and unknown create a mysterious atmosphere. The “Risk/Peril” pattern can be applied within play elements where children will be able to experiment with risk taking.

The Biophilic Design attribute of “Transitional Spaces” can be explored within the design of play elements as well as within the site design of different areas on the playground. “Cultural and

[169] Kellert and Calabrese, *The Practice of Biophilic Design*, 40.
[170] Browning, Ryan, and Clancy, “14 Patterns of Biophilic Design,” 48.

Ecological Attachment to Place” can be applied within landscape design, where Native Hawaiian plants and locally found natural sources could provide a Hawaiian sense of place.

As the playground will be divided into various areas according to children’s appropriate ages, I propose that not all biophilic principles will be equally valid and effective if applied in all areas. For example, “Mystery and Risk/Peril” is not a suitable principle to be applied in the “Egg” area, which is designed for children 0 to 2 years old. Among 16 biophilic design principles that I previous selected as being suitable for application on playgrounds, I separated them into 8 categories to be tested. To define which biophilic design principle are the most appropriated for each area of the playground, I created a matrix. See Figure 72. Each red dot on the diagram represents an opportunity for biophilic design principle application. In this way, I could identify which biophilic principles have the potential to be the most appropriate when applied to each area of the playground.

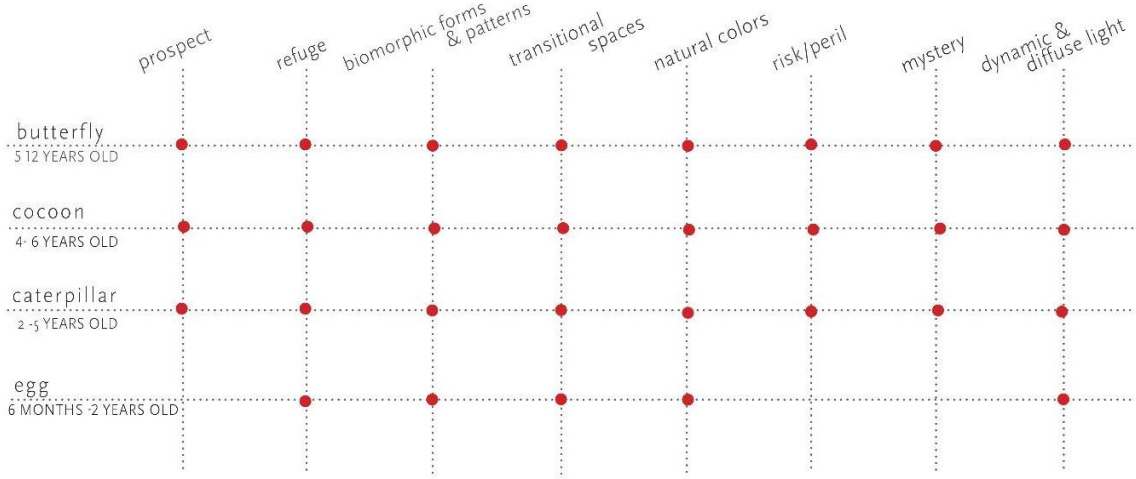


Figure 72. Biophilic Design Principles and the Occurrence of Each within a Playground Areas.

All eight principles described in “Design Strategy” can be appropriately applied within the Caterpillar, Butterfly, and Cocoon areas, since all the principles are suitable for children from 2 to

12 years old. However, not all principles can be applied within the Egg area since they all are not appropriate for children from 6 months to 2 years old, specifically their potential experimenting with risk/peril, mystery, and prospect experiences. The matrix within Figure 49 demonstrates that the most suitable biophilic design principles for children from 6 month to 2 years old are “Refuge,” “Biomorphic Forms and Patterns,” “Transitional Spaces,” “Natural Colors,” and “Dynamic and Diffuse Light.” This same matrix will be used to identify the biophilic design principles that are ideal for play elements, and, as such, the matrix will help to identify which play elements are more appropriated for which areas of the playground.

7.3 Biophilic Design Applied to Play Elements

As previously stated, taking inspiration from the concept of the life cycle of the butterfly and the use of organic and abstract forms, defined through biophilic design principles, the play elements were drawn according to the spatial investigation characteristics, which were previously demonstrated in the “Biophilic Design Applications” chapter of this dissertation. Each play element has been tested using the matrix tool, which helped to identify the biophilic design principle most predominant within each play element. These determinations will help with subsequent decisions regarding where each play element is best located within respective playground areas so as to be most beneficial for specific children’s ages.

Inspired by formations that occur in nature as a beehive, this playground element was primarily designed based on the biophilic design principles of Prospect and Refuge. See Figure 73.

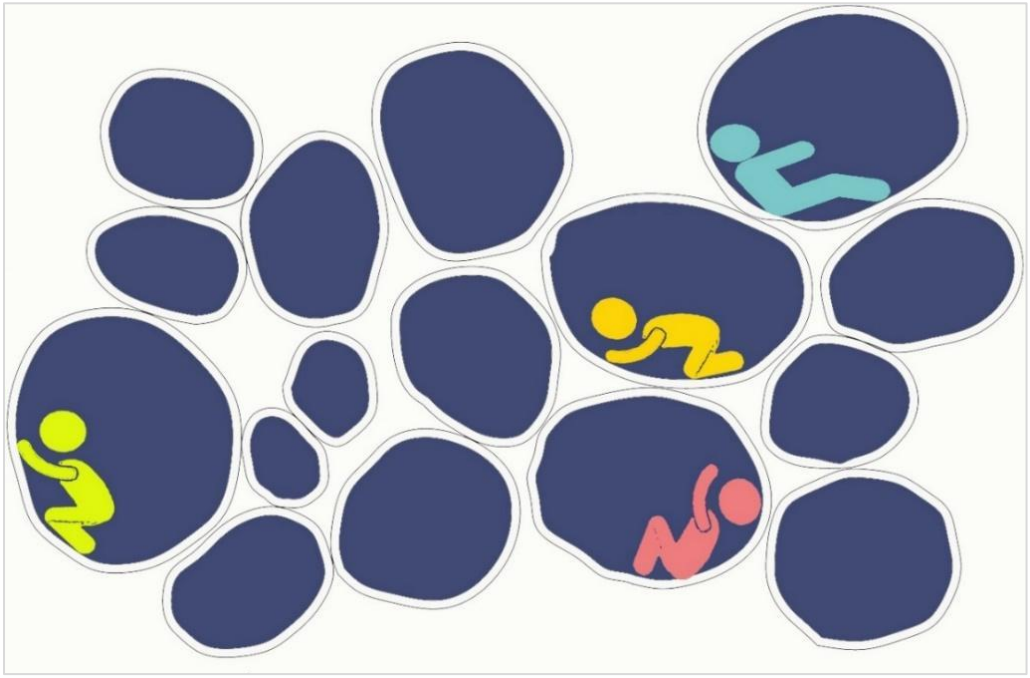


Figure 73. Hive Wall.

As was described within the “Biophilic Design: Spatial Investigation” section of this dissertation, to achieve a satisfying sense of refuge, the spatial configuration of place has to provide protection from behind and overhead and must promote a sense of resting, protection, and healing.[171] The Hive Wall has holes circular in shape and various in size so as to allow children to climb in and use the holes as refuge areas. A sense of refuge can be enhanced if combined with prospect characteristics providing a capacity to “observe (prospect) without being seen (refuge).”[172] The circular shapes of each niche are ergonomic in design for the child to sit in or to lie down, and

[171] Browning, Ryan, and Clancy, “14 Patterns of Biophilic Design,” 46.
[172] Ibid.

they allow children to climb to the highest point to reach the prospect's experience. The organic and abstract shapes of the openings allow for a variety of interpretations and leave space for creativity and imagination. The dimensions of this playground element must be designed respective to children's ages. Some rules regarding the maximum fall high (the distance between the top of the raised area and the cushioning surface underneath) that are described on a CPSC handbook. See Appendix. The Appendix can be used as a supplementary guide to designing this play element. The Hive Wall can also be used to divide spaces within the playground areas and adjacency. The matrix tool was used to evaluate which biophilic design principle is best expressed within each specific play element. Prospect, Refuge, Biomorphic Forms and Patterns and Risk/Peril are the predominant principles. Natural colors are also best applied within this play element. See Figure 74.

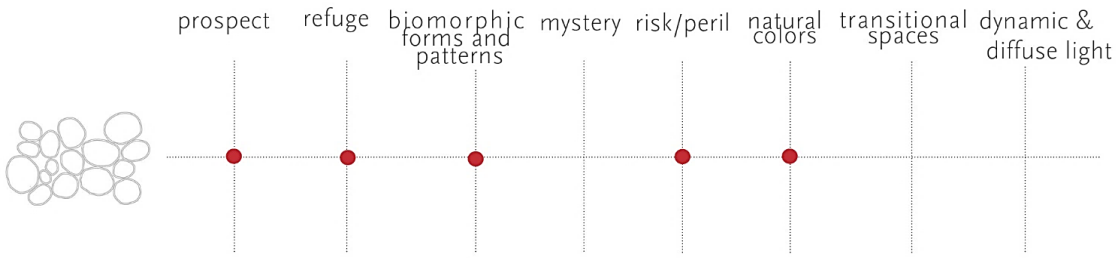


Figure 74. Hive Wall and Biophilic Design Opportunities.

Inspired by the undulate shape of the caterpillar, this playground element was primarily designed based on a biophilic design principles of prospect and Risk/Peril. See Figure 75.

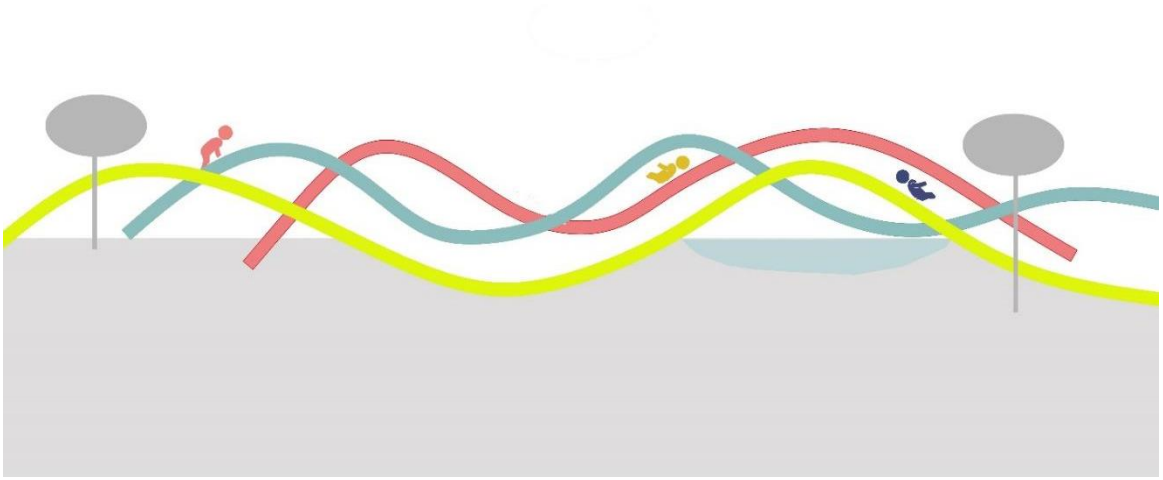


Figure 75. Sliding Bridge.

Spatial configuration of prospect can be archived with elevated spaces that provide an overview of the immediate surroundings. Risk/Peril is defined as “spaces that permitting the experience of risk without harm.”[173] The Sliding Bridge is designed to allow children to climb and slide providing a Prospect and Risk/Peril experience. The biophilic design experience of Prospect and Risk/Peril is combined with a biophilic design principles of “Visual Connection with Nature” to enhance the biophilic experience. This play element is designed to be integrated with natural elements like water and vegetation. From the highest part of the bridge, it might be possible to be close to or possibly even reach the treetop. The sliding part of the bridge will cross over a water feature (e.g. a rain garden or a water fountain). The Sliding Bridge can be designed to connect two or more areas of the playground. For example, children can take the bridge from the caterpillar area to the cocoon area.

[173] Browning, Ryan, and Clancy, “14 Patterns of Biophilic Design,” 50.

The matrix tool was applied to evaluate which biophilic design principle can be expressed in this specific play element. Prospect, Biomorphic Forms and Patterns, and Risk/Peril are the predominant principles. Natural colors can also be applied within this play element. See Figure 76.

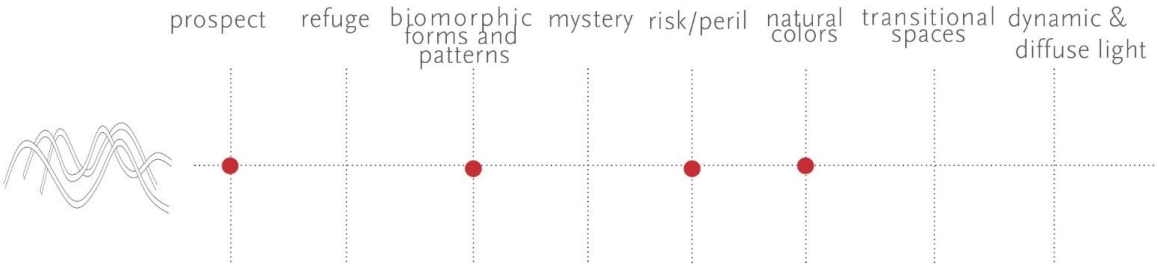


Figure 76. Sliding Bridge & Biophilic Design Opportunities.

Inspired by a cocoon of the butterfly, this playground element was primarily designed based on biophilic principles of Refuge, Biomorphic Forms and Patterns, and Dynamic and Diffuse Light. See Figure 77.

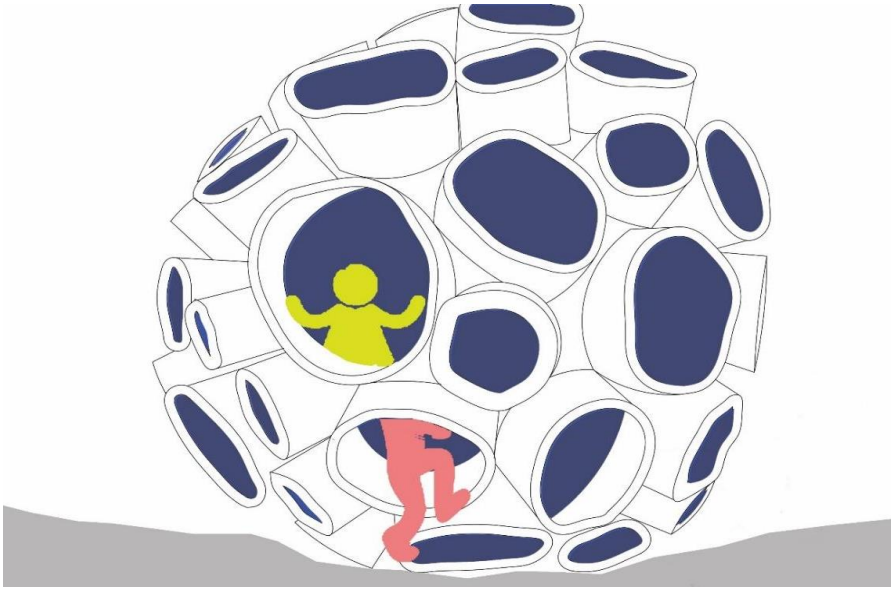


Figure 77. Cocoon.

The Cocoon is designed to allow children to climb up and enter, so as to experiment with a refuge type of experience. The openings provide a variation of light incidences that create diverse patterns of shadows inside. The abstract shape of the play element allows for imagination since the structure does not dictate how children play. Once inside, children can look up to the sky from various angles and also experiment with diverse outside views from the many openings. The matrix tool was applied to evaluate which biophilic design principles can be expressed within this specific play element. Refuge, Biomorphic Forms and Patterns, Transitional Spaces, and Dynamic and Diffuse Light are the predominant principles. Natural colors can be applied within this play element, as well. See Figure 78.

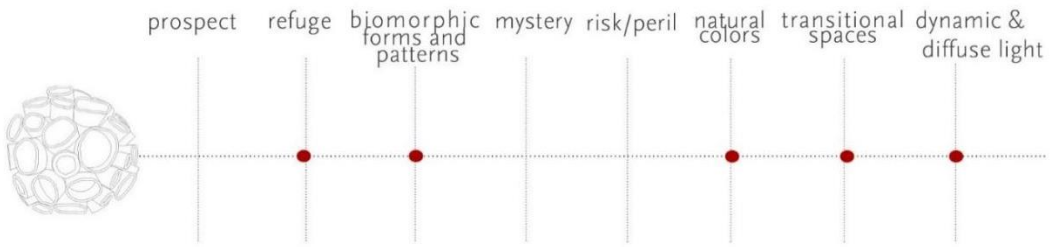


Figure 78. Cocoon & Biophilic Design Opportunity

This playground element was primarily designed based on the biophilic design principle of Mystery. See Figure 79.

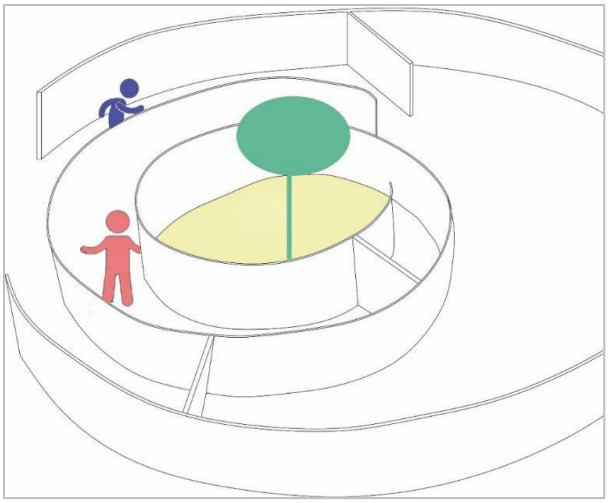


Figure 79. Labyrinth.

Mystery, as a biophilic design concept, originates from the idea that "people have two basic needs in environments: to understand and to explore."[174] As was discussed in the "Biophilic Design: Spatial Investigation" section of this dissertation, mystery requires movement from the spectator in order for it to be manifested. It can be expressed through spaces that encourage exploration with a sense of compensation at the end. The Labyrinth is designed to entice children to explore and to further investigate the space. To enhance the biophilic design experience, this play element can be integrated with nature. The circular shape leads to the center, and the center can be filled with diverse natural elements (e.g. water, rocks, sand, and vegetation). Because the experience of mystery might diminish with regular exposure to the Labyrinth, strategies that encourage shifting or rotating within a given context are effective for maintaining a sense of mystery within this playground structure. "Connection with Natural Systems" is defined as an awareness of seasonal and temporal changes within nature's processes. Applying the "Connection with Natural System" principle is one way to increase the sense of mystery when one interacts with this play element. It can be achieved, for example, using seasonal trees or a rain garden that will change appearance throughout the changing seasons. The matrix tool was

[174] Browning, Ryan, and Clancy, "14 Patterns of Biophilic Design," 48.

applied to evaluate which biophilic design principles can best be expressed within this specific play element—Mystery, Biomorphic Forms and Patterns, Risk/Peril, Transitional Spaces, and Dynamic and Diffuse Light. See Figure 80. Natural colors can also be applied within this playground element.

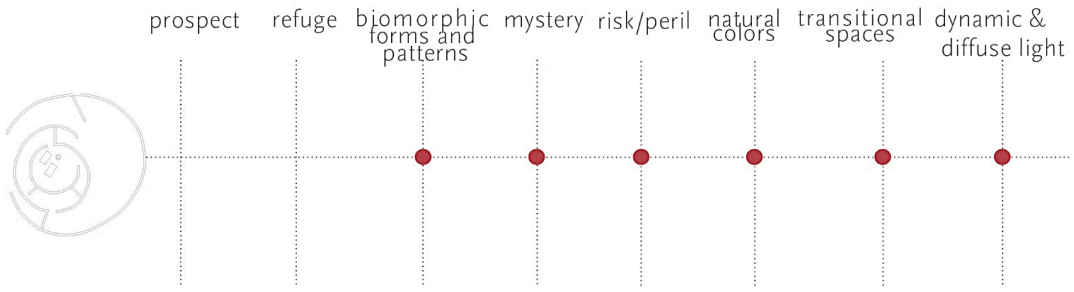


Figure 80. The Labyrinth and Biophilic Design Opportunities.

This playground element was primarily designed based on a biophilic design principles of Refuge and Mystery. See Figure 81.

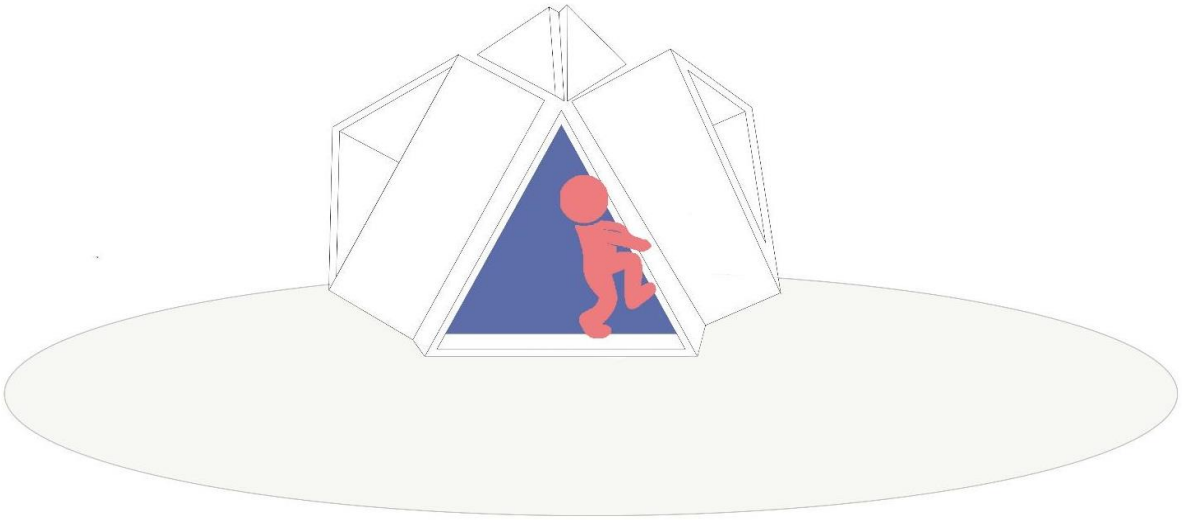


Figure 81. Pyramid.

The Pyramid is designed to allow children to go inside and experiment within a refuge-based experience. The Pyramid's openings provide a variety of views to the outside. The abstract shape also nurtures children's imaginations since it does not dictate how the children must play when within it. Even the pyramidal shape evokes a sense of mystery. This playground element can be integrated with natural features so as to enhance the overall biophilic design experience (e.g. within a sandbox). As with all other playground elements, the matrix tool was applied to evaluate which biophilic design principles can be best expressed within this specific playground element. Refuge, Mystery, Transitional Spaces, and Dynamic and Diffuse Light are the predominant principles, and natural colors can be applied within this playground element. See Figure 82.

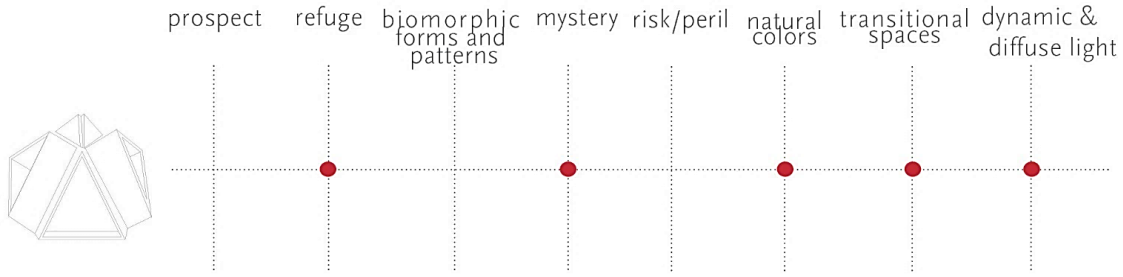


Figure 82. Pyramid & Biophilic Design Opportunities.

All the information from the matrixes were combined to create a master matrix so as to represent which Biophilic Design principles are most predominant regarding each playground element. See Figure 83.

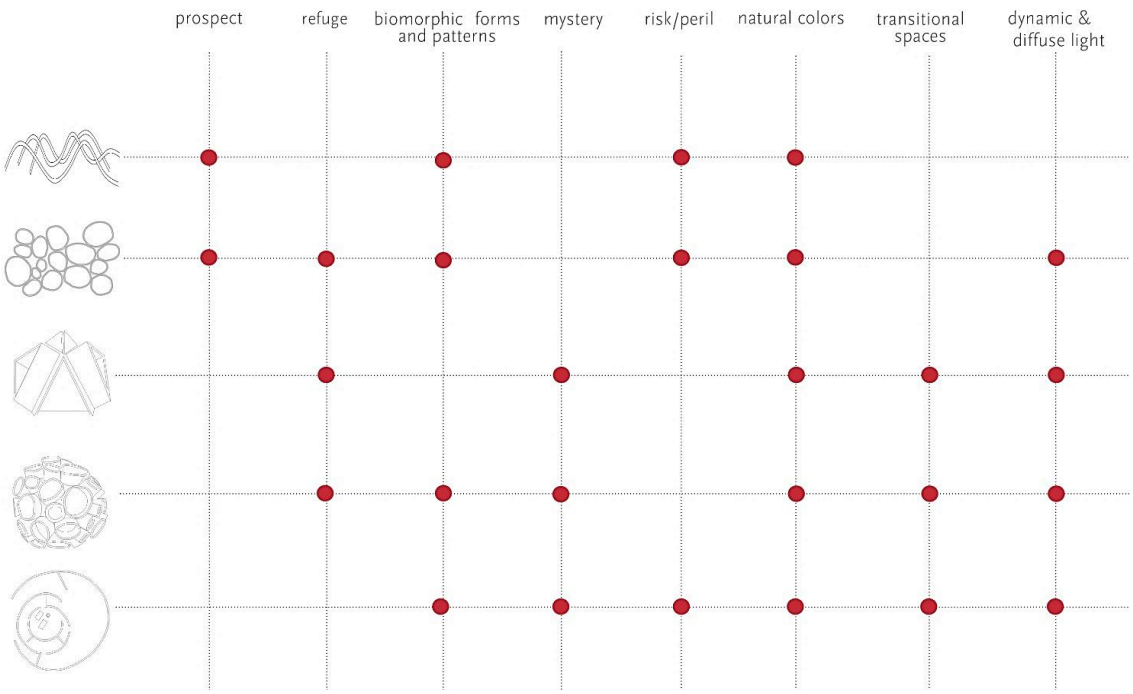


Figure 83. Biophilic Design Principles and Play Elements.

7.3 Biophilic Design Principles and Playground Layout

Combining the information from the first matrix, Figure 72, which demonstrated where each biophilic design principle will be most appropriate for each area within the playground, with the master matrix, Figure 83, which demonstrates the opportunity for biophilic design principles to be incorporated in the design of each playground element. As such, together they will inform design decisions regarding where each playground element should be located within a playground areas. Considering children's ages, the first matrix demonstrated that ideal areas for children to experiment prospect are the Caterpillar, the Cocoon and the Butterfly. The opportunity for a prospect-based experience happens on the Sliding Bridge and the Hive Wall. Refuge type environments are appropriate for all playground areas and can be experiences in the Hive Wall, the Pyramid Garden, and the Cocoon. Therefore, these playground elements can be included in

all areas of the playground site. The first matrix showed that playground areas most suitable for children to experiment Risk/Peril are the Caterpillar, the Cocoon, and the Butterfly. The play element that has the most opportunity for Risk/Peril is the Sliding Bridge, the Hive Wall. The first matrix also showed that playground areas most suitable for children to experiment with Mystery are the Caterpillar, the Cocoon, and the Butterfly. The play elements that best embrace the Mystery characteristics are the Pyramid, the Cocoon, and the Labyrinth.

7.5 Material Selection for Play Elements

The materiality of an environment plays an integral part of the design and experience of the space. Each material interacts differently with one's senses and emotions. This dissertation emphasizes the need for exposure to nature and biophilic design in children's playgrounds. To stay true to this dissertation's hypothesis, the criteria for the material of the playground must coincide with the biophilic design principals of using natural and composite materials such as, wood, clay, natural fibers, stones, sand, native metal, concrete, cast stone, terrazzo, and other natural materials.

According to biophilic design, there should not be any straight lines or right angles, only organic shapes. While most building materials can achieve organic shapes, some require a more rigorous and time-consuming process. These playground elements should be lightweight (to make them transportable to other abandoned lots) as well as easy for mass production. Therefore, the material must be relatively lightweight, but strong enough to endure transportation. Out of the natural and composite materials listed, the two types of materials that can be transported easily, are relatively lightweight, and can be easily formed into organic shapes for mass production, are wood and concrete. Clay, terrazzo, and stone can be brittle, therefore not suitable for frequent transportation. Consequently, both wood and concrete will be analyzed for their strength, abilities, and feasibility for the proposed designs.

Wood is one of the natural elements that is most commonly used as a building material. It has many beneficial features that make it a great material to work with. First, it is a renewable resource and, if untreated, can be reintroduced into nature.[175] The strength of wood depends on the type of wood—softwood or hardwood—with each type having different compression and tensile abilities. It also depends on the way the grain runs in conjunction to the applied force. The strength of the wood is based on "the greater the gross density; the higher the compressive strength, the sound insulation value, and the thermal storage capacity of a material. But despite its relatively low gross density, wood has a comparatively high bending, tensile, and compressive strength, as well as high strength parallel to the direction of the fibers."[176]

Softwoods (conifers) grow rapidly and with an even structure.[177] Hardwoods, on the other hand, grow much slower and are not as straight in their growth pattern. The various types of woods have different bending abilities and can be combined to create a stronger building material. For example, cross-laminated timber (CLT) exists as three layers of softwood that are stacked and glued. The grains of each layer must run perpendicular to each other to optimize the strength. The process of using thinner slices of wood can be used to achieve a curved shape. This process is conducted by layering thin strips of wood, applying glue between the layers, and applying pressure (clamping these layers to a mold) and sometimes applying heat.[178] Once the glue is dry, the pressure is removed, and the wood remains in the same curved shape. Wood can also be bent through steam bending. The piece of wood is heated to a temperature of 100 degrees Celsius and then clamped to a mold. Another way that curves are achieved is called kerfing (or bending by slicing.)[179] The proposed design elements consist of organic shapes, which would require many pieces of wood to complete the structure and may take more time to construct. The curving design of the proposed playground equipment would help to determine which type of

[175] Barbara Glasner and Stephen Ott, *Wonder Wood: A Favorite Material for Design, Architecture and Art* (Basel, Switzerland: Birkhäuser, 2013), 261.
[176] Ibid, 260.
[177] Ibid, 261.
[178] Ibid, 264.
[179] Ibid, 270.

wood to use. While wood can be bent and manipulated into organic shapes and curves, the process is much longer and more tedious than using concrete to create these playground elements. “Over the last decades prefabrication (or pre-casting) in reinforced concrete has become increasingly important in building and civil engineering construction. When combined with rationalism, mechanization and modularization it enables a product to be made in large quantities and at a reasonable price.”[180] The creation of molds facilitates the production of mass production of building elements, or for this dissertation, playground elements.

Concrete, while typically a heavier material, exists as newer types that are made to be lighter weight and increased strength. This change is achieved through the combination of fibers into the concrete. These fibers increase the tensile strength of concrete, which is typically weak in tension. Glass Fiber Reinforced Concrete (GFRC), “is an ideal material for building envelopes because it is durable. It can resist fire and the environmental impact is low compared to other materials, because the base materials used in the production of GFRC are widely available throughout the world.”[181] There are various ways in which the concrete can be applied to a mold: automated premixed method, the premixed method, and the sprayed method. In order to achieve “a smooth surface texture, no visual fibers in the surface, minimal air-bubble or voids, consistent color across all thin walled GRFC elements, no visible cracks, and the need for edge-returns and panel offsets, “the best method is the spray method.[182] GRFC is a suitable material in order to achieve the complex geometry of the proposed playground elements. The use of GFRC concrete versus typical concrete has many benefits. The “addition of glass fibers increases the energy required for crack propagation which in turn improves the toughness o the material. The increase in compressive strength of concrete of various grades at different testing ages ranges from 20%

[180] G.B. Kim, K. Pilakoutas, and P. Waldron, "Development of GFRP-reinforced GFRC for Thin Permanent Formwork Applications." *Magazine of Concrete Research* 62, no. 4 (April 2010): 283–90, https://doi.org/10.1680/macr.2010.62.4.283.

[181] Thomas Henriksen, Stephen Lo, and Ulrich Knaack. "A New Method to Advance Complex Geometry Thin-walled Glass Fibre Reinforced Concrete Elements." *Journal of Building Engineering* 6 (2016): 243–51, https://doi.org/10.1016/j.jobe.2016.04.002.
[182] Ibid, 2.

to 30% due to addition of glass fibers. Similarly, the increase in flexural strength and split tensile strength ranges from 25% to 30% as compared to plain cement concrete."[183] In order to additionally strengthen the GFRC, external confinement can be utilized. "Confinement can improve both the compressive strength and ductility of concrete. Fiber Reinforced Polymers (FRPs) are the most commonly used confinement material."[184] This material is then topped with a layer of GFRC to create the smooth surface. The use of GFRC to create playground elements is not new, however, and there are various companies that already offer playground elements using GFRC, thus supporting the justification of using this material. The company *Cre8play* has an online catalog of various playground equipment that is modeled to look like elements in nature. These include a fallen tree log, a rock formation, tree stumps, a leaf bench, and even a hay barrel[185]

[183] Liaqat Ali Qureshi, Junaid Ahmad, and Hamad Salahuddin, "Seismic Vulnerability Assessment of Strengthened Glass Fiber Reinforced Concrete (GFRC)," *KSCE Journal of Civil Engineering* 21, no. 6 (December 2016): 2235–244.
[184] Ibid, 1.
[185] Cr8play, "All Products." Cre8play Product Comments, accessed October 04, 2017, http://www.cre8play.com/product_category/.

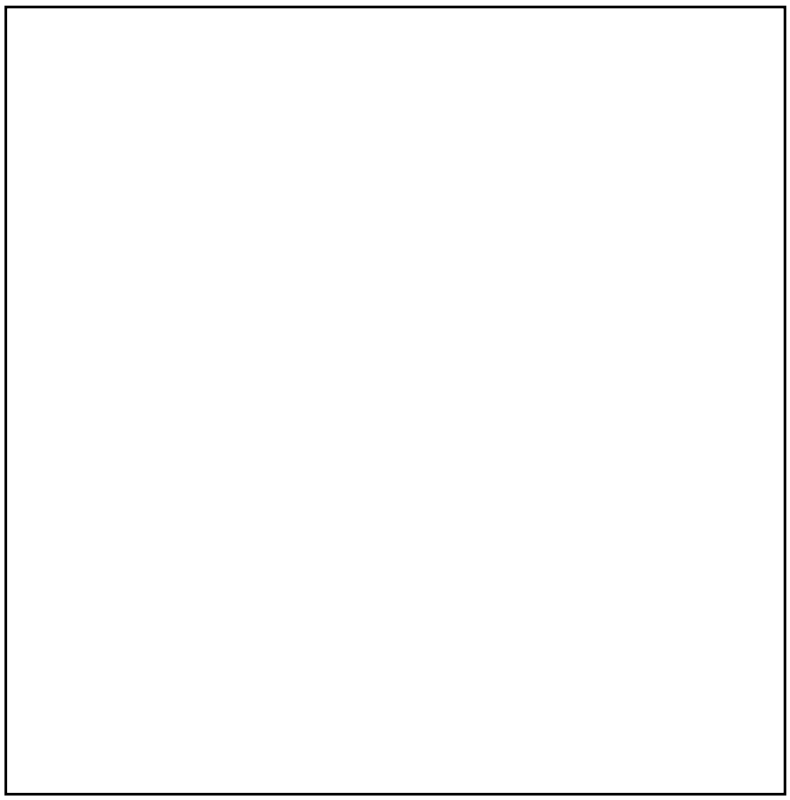


Figure 84. A Leaf-like bench made from GFRC. (Reproduced from http://www.cre8play.com/product_category/)

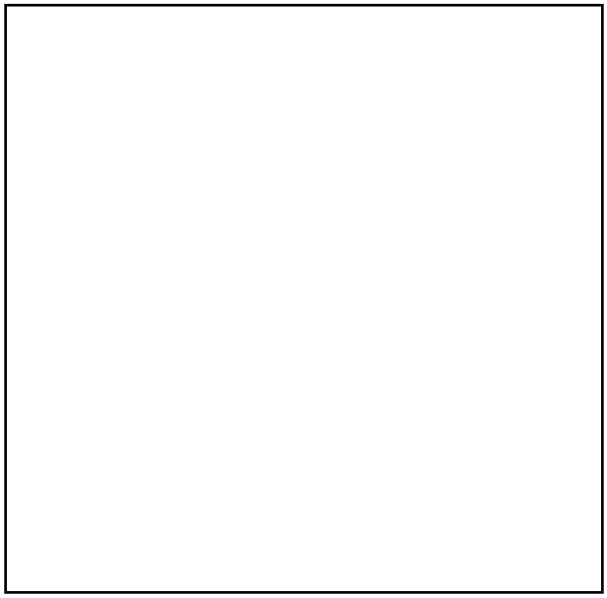


Figure 85. A hallow fallen tree stump made from GFRC. (Reproduced from http://www.cre8play.com/product_category/)

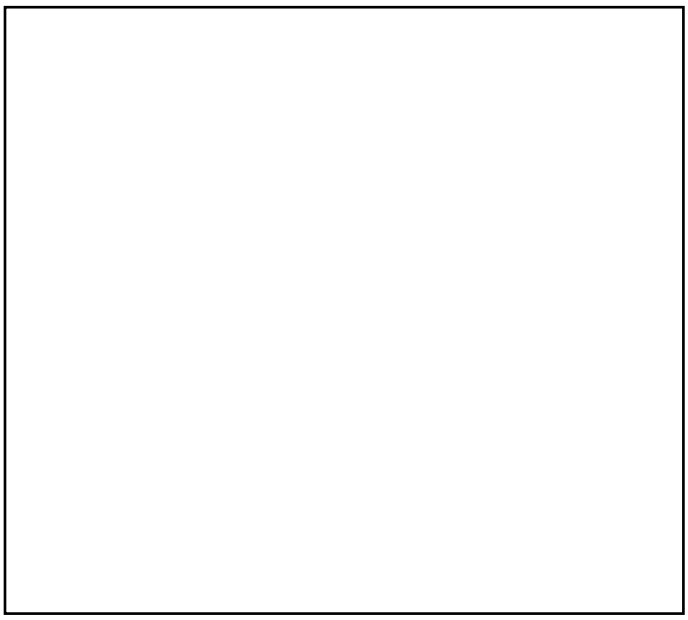


Figure 86. Tree stump playground equipment made from GFRC. (Reproduced from http://www.cre8play.com/product_category/)

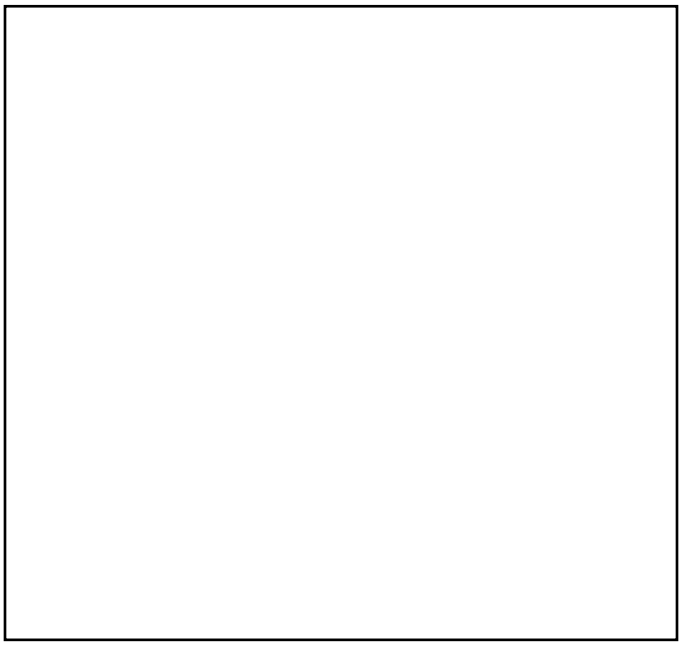


Figure 87. Playground Equipment resembling a natural rock formation made from GFRC (Reproduced from http://www.cre8play.com/product_category/)

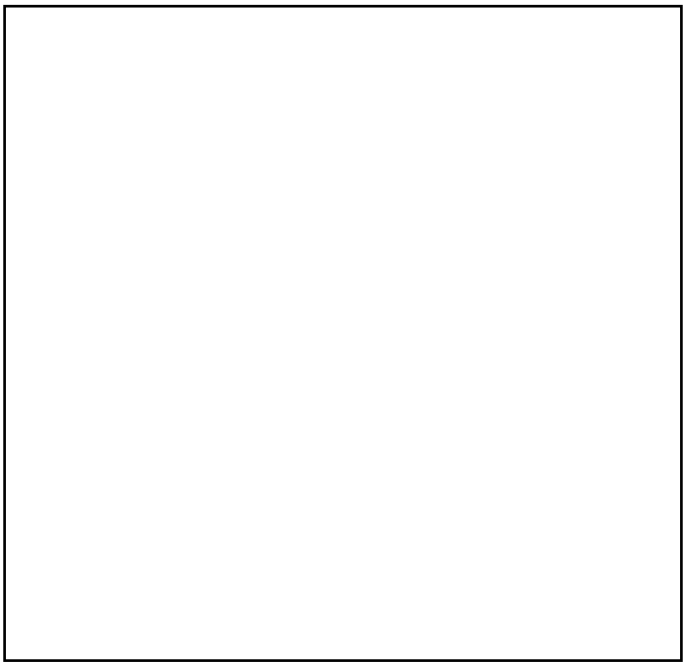


Figure 88. Children's slide that resembles a tree made from GFRC. (Reproduced from http://www.cre8play.com/product_category/)

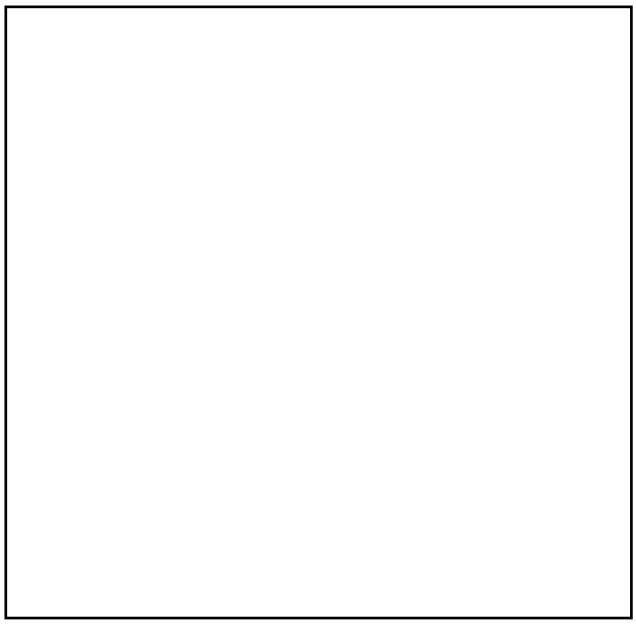


Figure 89. Bench that resembles a hay barrel. (Reproduced from http://www.cre8play.com/product_category/)

Using GFRC as the building material for the proposed playground elements allows for color and texture to be applied to the design. This will promote the use of the children's senses and

creativity. GFRC is also a much better alternative to typical concrete because of its lightweight ability to create thin elements and its compressive and tensile strength.

8 Chapter 8. Site Design

8.1 Layout

As was discussed within the “Design Concept” chapter of this dissertation, the playground areas will be divided according to the children’s age. Inspired by the life cycle of a butterfly, the areas will be called Egg, Caterpillar, and Butterfly with an overlapped area called Cocoon. See Figure 90.

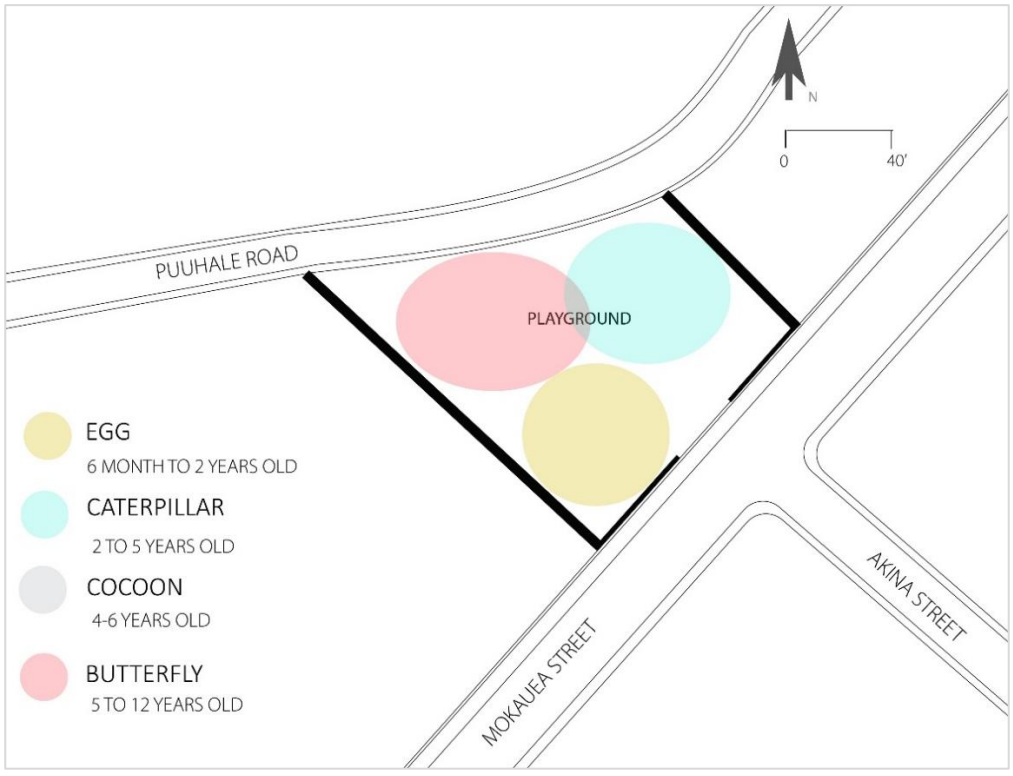


Figure 90. Playground Areas.

The Egg area, which is designed for children from 6 months to 2 years old, will be located on a corner of the site and separated from others areas to avoid conflicting activities. The Egg area will be located close to the entrance to allow easy access for parents and caregivers. Because toddlers need more supervision than preschoolers or school age children, the area for parents and caregivers will be located on an Egg area. The Caterpillar area is where pre-school children ages 2 to 5 years old are designed to play. The Butterfly and Caterpillar areas are more integrated with each other and overlap with the Cocoon area between them. Given the analogy of the story of the butterfly, described within the “Design Concept” chapter of this dissertation, the Cocoon area is where children will have more challenging elements with which to play. It will be where the most challenging biophilic design principles of Risk/Peril will be applied within the overall design of the playground. The Butterfly area designed for children from 5 to 12 years old, and it is where the principles of Risk/Peril and Mystery will be most expressed on a play elements and site design. See Figure 91.

Figure 91. Playground Areas.

Situated between two streets the playground will have two accesses. The principal access is by Mokauea Street and the secondary by Puuhale Street. The Americans with Disabilities Act (ADA) dictates that discrimination on the basis of disability is prohibited by law.[186] In addition, in 2000, the U.S. Access Board published its official guidelines regarding play areas.[187] These guidelines were implemented as a law in 2010, and by March 15, 2011, all play areas throughout the entire U.S. were required to be in minimum compliance. See Appendix. The overall design of the playground will be in accordance with ADA accessibility, including the fact that all areas of the playground will have a surface material that is in accordance with ADA surface requirements See Figure 92.

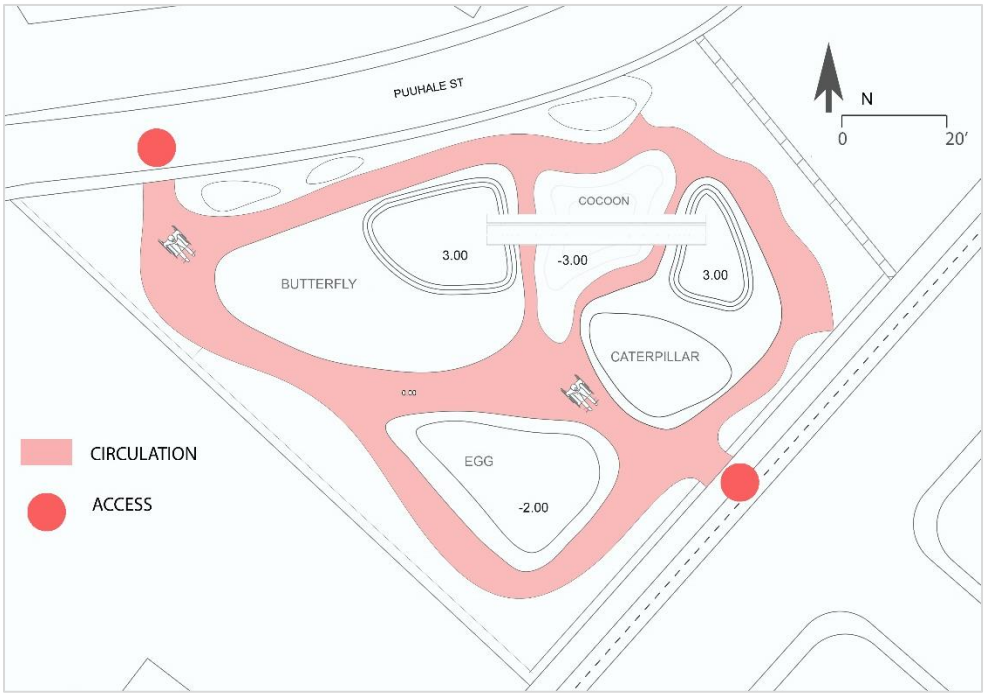


Figure 92. Playground Layout with Circulation and Access.

[186] https://www.ada.gov/
[187] https://www.access-board.gov

To facilitate wayfinding, directional signs with different colors should be located within the playground to indicate different areas. The diagram below shows the circulation path for each area of the playground. See Figure 93.

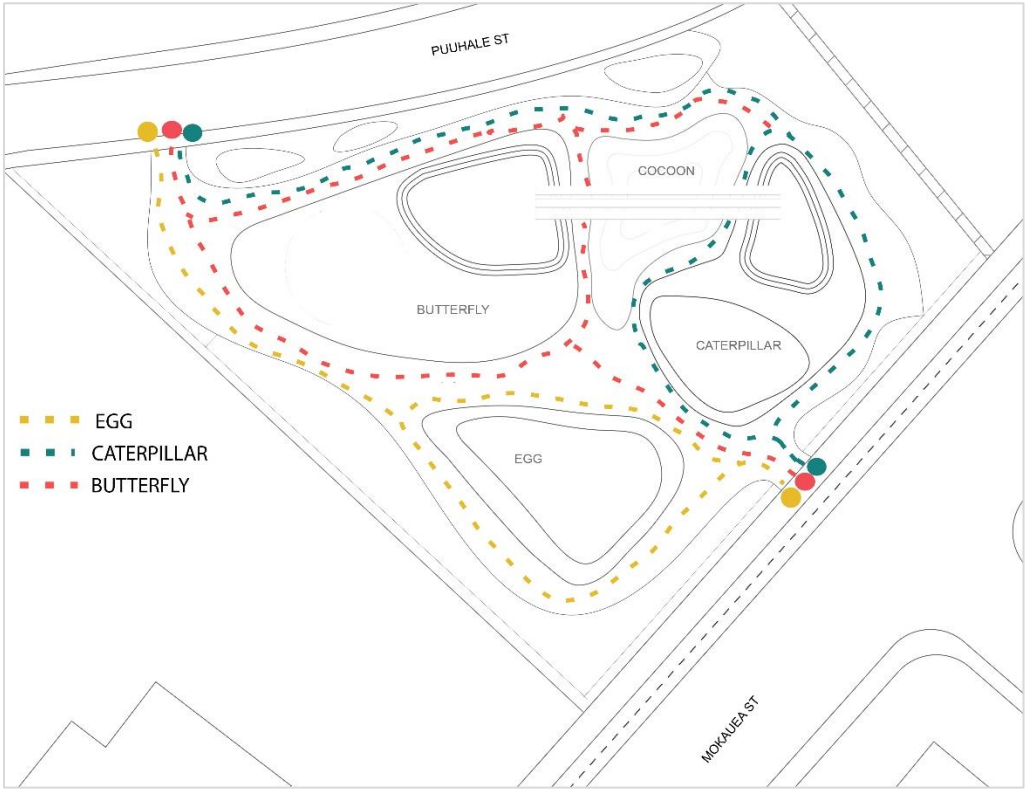


Figure 93. Circulation Path of Playground Areas.

8.1.1 Biophilic Design Principles Applied to Layout

Following the biophilic design principles as a main driver, I propose that the site and all play elements should be integrated with nature and designed to incorporate biophilic principles. The playground areas are designed with slope to create spaces that allow for the application of biophilic design principles of prospect and refuge. The attributes and patterns of “Nature in the Space” and “Direct Experience of Nature” are applied to the overall site design and landscape through the use of natural materials like wood, stone, sand, and water.

To apply the “Non-Visual Connection with Nature” principle, a sensorial garden is designed to create spaces that encourage sensorial stimuli such as auditory, haptic, olfactory, or gustatory. Diversity of plants that can stimulate a sensorial experience will also be applied within the design of this area, for example plants that exude fragrance, edible plants, and non-poisonous plants that can be touched. The sensorial garden is located on a playground adjacent to Puuhale Street to allow easy access from the pedestrians and individuals from the neighborhood community who could possibly contribute to the maintenance and management of the garden. The “Connection with Natural System” principle is applied to the design of a rain garden. The rain garden is located within the Cocoon area of the playground, where children from 4 to 12 years old can take advantage of playing close to the water feature. As part of the “Connection with Natural System” principle, seasonal trees will be included within the landscape design. Seating opportunities will be provided for caregivers to be comfortable while watching their children and to promote spaces for socialization. Having comfortable spaces that are designated for caregivers will encourage them to bring their children to play. Benches will be located on the boundaries of the Egg area to allow for an overview of the entire playground area. The Egg area has a slope that is 2 feet below the circulation level to allow children to exercise climbing and sliding and also to keep them under caregiver’s supervision in a comfortable environment. See Figure 94.

Figure 94. Playground Layout.

8.1.2 Play Elements within the Playground Layout

The combination of matrices help to dictate the location of each playground element within the overall playground. According to the appropriate biophilic design principle in relation to children's respective ages, I propose that the play elements be located as follows: The pyramid will be located in Egg area, the Cocoon will be located on a Caterpillar area, the Sliding Bridge will be located on Cocoon area, the Labyrinth will be located on the Butterfly area, and the Hive Wall will be located as an adjacency wall close to Caterpillar area. See Figure 95.

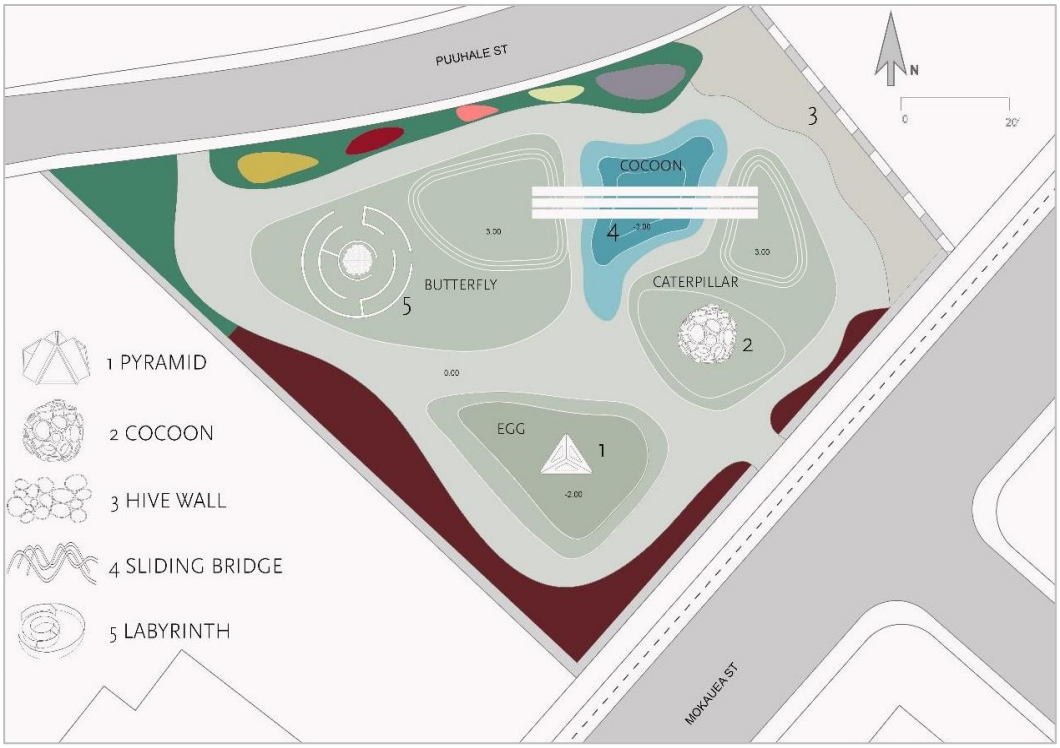


Figure 95. Play Elements within the Layout.

8.2 Landscape Design

The “Nature in the Space” category, discussed in the “Biophilic Design” chapter of this dissertation, was defined as a direct physical presence of nature that is integrated in a built environment. Derived from “Nature in the Space “category, the “Connection with Natural System” is a principle that will be applied within the playground’s site design through the inclusion of seasonal plants. Play element and playground areas are integrated with deciduous trees so children can experiment awareness of seasonal and temporal changes. The principle of “Non-Visual Connection with Nature” is applied within a sensorial garden where plants that exude fragrances, as well as edible plants, can be experimented with so children can obtain a positive connection with nature. The “Cultural and Ecological Attachment to Places” is part of “Experience of Space and Place” attribute that was also described on a “Biophilic Design” chapter of this

dissertation. To incorporate the “Cultural and Ecological Attachment to Places,” Hawaiian plants will be considered to a landscape design. The figures below demonstrate the location and occurrence of all 16 biophilic design principles that were selected and applied on a playground design and landscape. See Figure 96, Figure 97 and Figure 98.

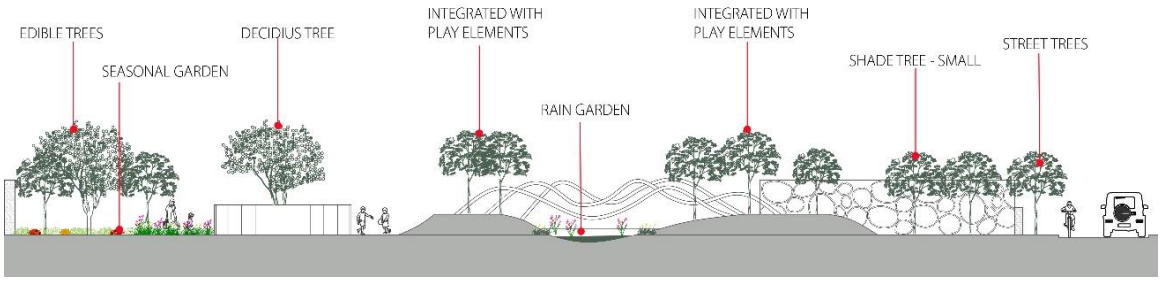


Figure 96. North Elevation with Trees.

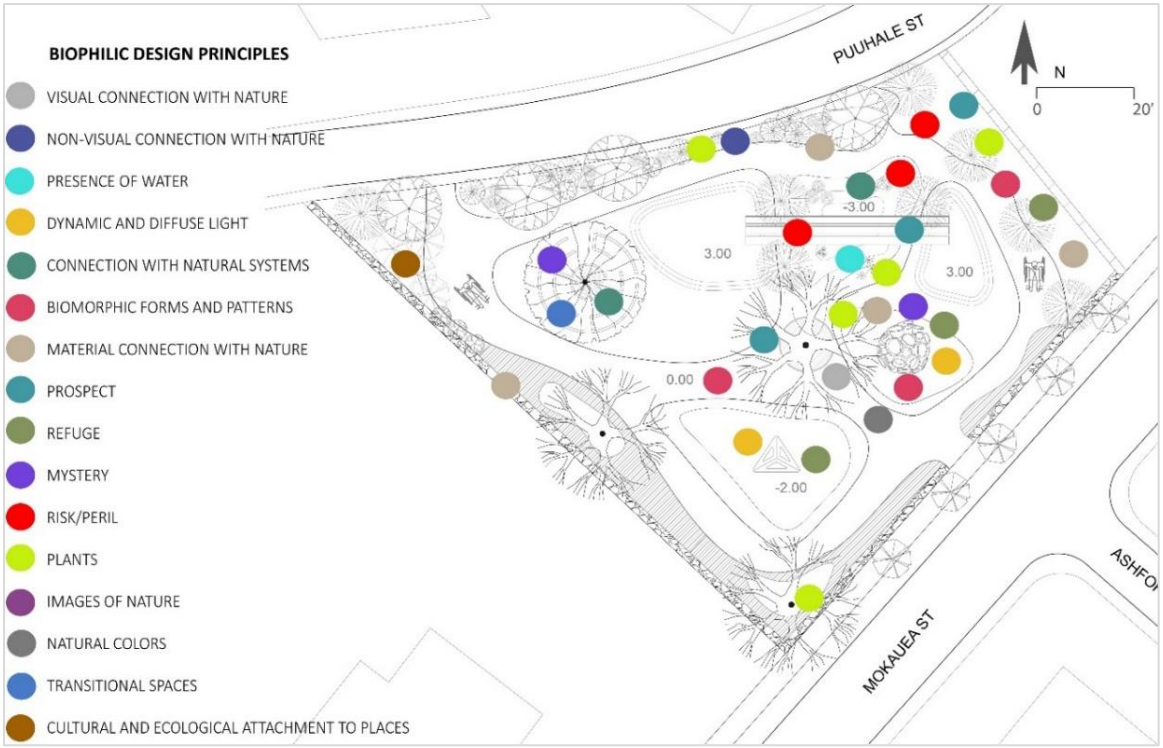


Figure 97. Biophilic Design Principles Placement.

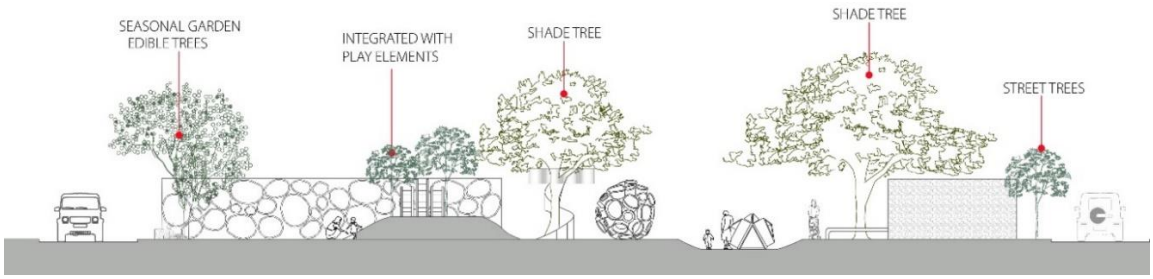


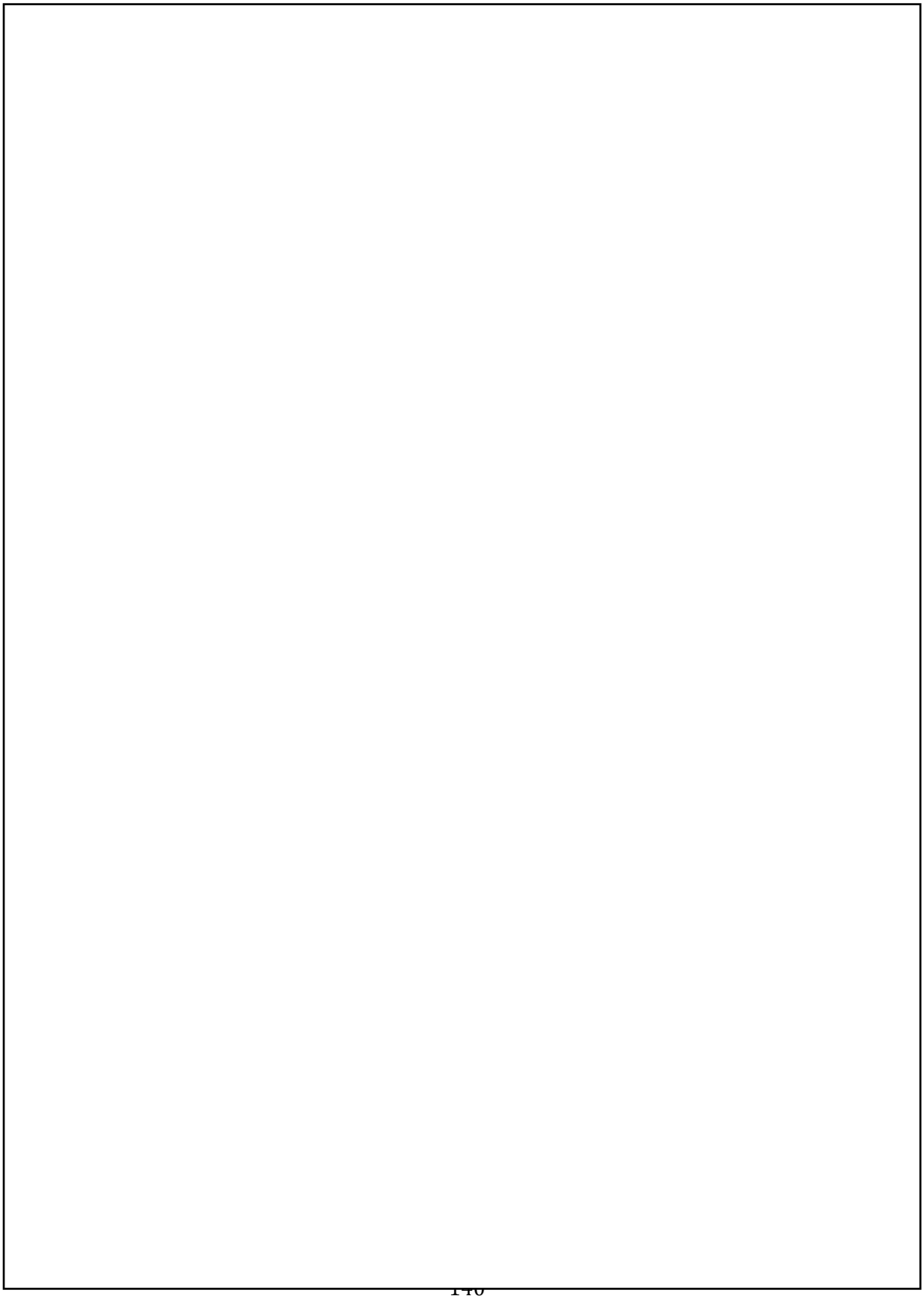
Figure 98. East Elevation with Trees.

8.2.1 Vegetation

Hawai'i has seventeen commonly found butterfly species.[188] To enhance the biophilic design principle of "Cultural and Ecological Attachment to Places" and to make a connection to the design concept of this playground, plants that attract butterflies will be applied within the landscape design of the playground. Species that are poisonous and that attract bees will be avoided. Some species to be considered are described on the following table. See Table 7

Table 7. Hawaiian Plants for Playground Areas.

[188] "Hawaii's Butterflies," Butterfly Society of Hawaii, http://butterflysocietyofhawaii.org/hawaiis-butterflies/.



Three types of trees will be considered for the playground areas. They are shade trees, fruit trees and deciduous trees. Shade trees have a large canopy and will be designed to promote shaded spaces in which children can play and in which parents and other caregivers can sit. According to the sun's orientation, shade trees will be located to allow morning sun to reach play areas but to avoid afternoon sun. Fruit trees will be located along a sensorial garden, where the community can have easy access to help to maintain the trees and enjoy the edible fruits. The deciduous trees will be integrated with play elements (e.g. Labyrinth, Hive Wall, and Sliding Bridge) so children can experience the seasonal changes. See Table 8.

Table 8. Hawaiian Trees for Playground Areas.

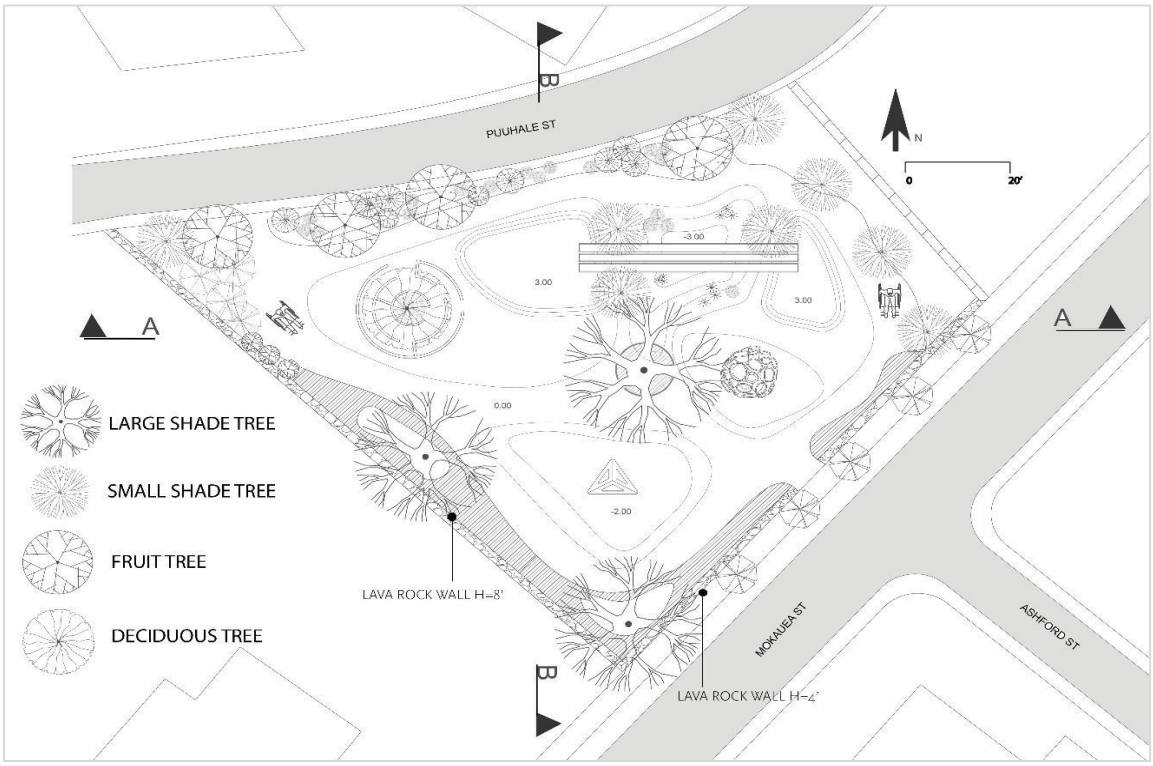


Figure 99. Trees Location on Playground Areas.

8.2.2 Materials Specification–Surfacing

Criteria for material selection for the design of the playground is included within the specification for each play element and for the layout's ground surface. The biophilic design principle of "Nature in the Space" addresses that the direct and physical presence of nature will be considered within a built environment. Therefore, natural materials or materials that mimic nature will be considered. In addition, the material selection for the surfacing will be in compliance with CPSC Handbook and ADA guidelines that are described within the Appendix of this dissertation.

8.2.2.1 Circulation area

For the circulation area, the material specification is composed of poured-in-place rubber mats. This material exceeds ADA standards and is universally acceptable for children with disabilities[189] (See appendix). It exists as a 2-layer system consisting of a base mat of 100% post-consumer recycled Styrene Butadiene Rubber (SBR) and polyurethane, along with a top surface consisting of recycled post-industrial Ethylene Propylene Diene Monomer (EPDM) rubber and polyurethane. It comes in various colors that can be mixed together to achieve the desirable final color. To be in accordance with biophilic design principles, natural colors will be selected. For example, beige, eggshell, brown, and pearl colors from the following figure can be considered. See Figure 100.

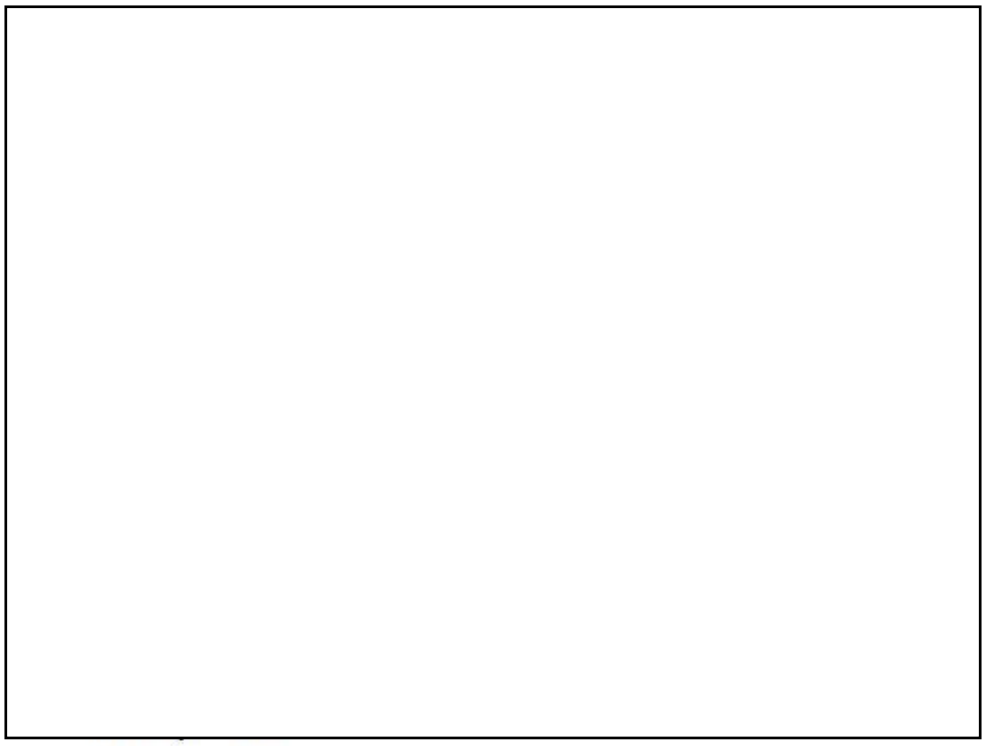


Figure 100. Pour-in-Place Rubber Mats Color Option.

[189] U.S. Consumer Product Safety Commission, "Public Playground Safety Handbook," 9.

8.2.2.2 Play Areas

According to the CPSC handbook, the surfacing of a playground is a key factor to be considered in relation to individual's injury from falls and so as to maintain overall accessibility. See Appendix. The surfacing under and around the playground equipment is the most significant aspect for the prevention of life-threatening injuries. Excepted for the Egg area, all play surfacing areas will be specified with Engineered Wood Fiber (EWF). It is made from a 100% virgin wood product, similar in appearance to landscape mulch, but is specifically designed for playgrounds.[190] The material must be certified to meet the American Standard for Testing and Material (ASTM) for specifications for impact attenuation (F1292) and wheelchair accessibility (F1951).[191] See Appendix. EWF can be used for play structures that have a fall height up to 10 feet because the fibers provide a surface that is bouncy enough to cushion falls yet firm enough for wheelchairs to roll upon it. See Figure 101.

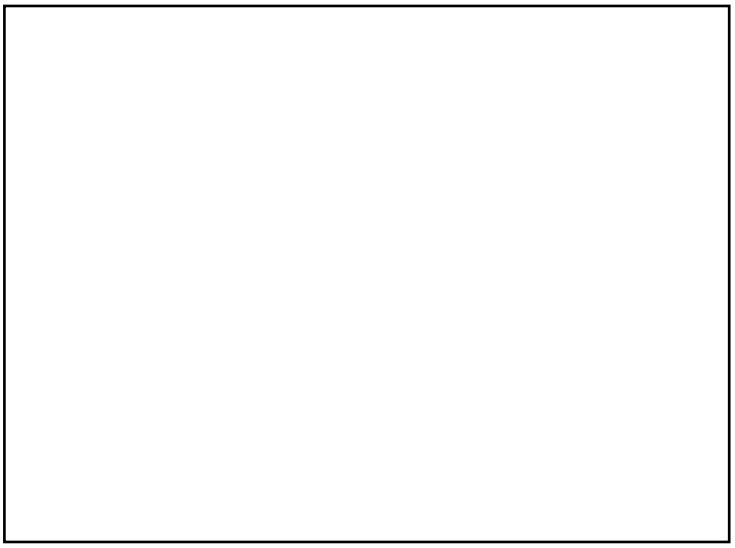


Figure 101. Engineered Wood Fiber.

[190] "Fibar Engineered Wood Fiber," Fibar Playground Surfaces, http://www.fibar.com/playgrounds/ewf.htm.
[191] Ibid.

So as to be applied the biophilic design principle of “Nature in the Space” and also to incorporate the “Cultural and Ecological Attachment to Places,” sand will be considered within some playground areas. Sand will bring a Hawaiian sense of place into the playground design and is one of the easiest and most affordable products to find and maintain. According to the U.S. Consumer Product Safety Commission (CPSC), sand applied upon playground surfaces has to be at a minimum depth of 12 inches in areas that are surrounding play equipment with a six-foot drop or fall zone.[192] One of the advantages of using sand on the floor of playground areas is its initial low cost and relatively easy installation. The downside of using sand is that it can attract cats that might use it as a litter box. River or beach sand is safer to use within playgrounds than sand that is made from crushed rock or crystalline silica. The silica is composed of quartz stone and is a known carcinogen. One form of asbestos called Tremolite is another recognized carcinogen that can also be found in some brands of playground sand. To keep the sand clean, it should be periodically replaced every year or two.[193]

Another example of an appropriate surface material to be used in playground areas, described within the U.S. Consumer Product Safety Commission (CPSC) handbook, is pea gravel. See Figure 91. These small stones are found near bodies of water and the result of natural weathering gives it a smooth texture. Pea gravel comes in sizes from 1/8 inch to 3/8 inch and in a range of natural colors like buff, rust brown, shades of gray, white, and translucent. The advantages of using pea gravel are that it is an inexpensive material, is easy to maintain, and does not attract cats. Besides being used in play areas, pea gravel can be used on a landscape design. The pea gravel will be used as surface cover within the sensorial garden of the playground, where children can walk on a textural surface while they experiment their contact with the plants growing there.

[192] https://www.cpsc.gov/
[193] Healthy Schools Network, “Playgrounds & Toxic Threats,” HealthySchools.org, last modified August 2010, http://www.healthyschools.org/HSNPlaygrdGuide.pdf.

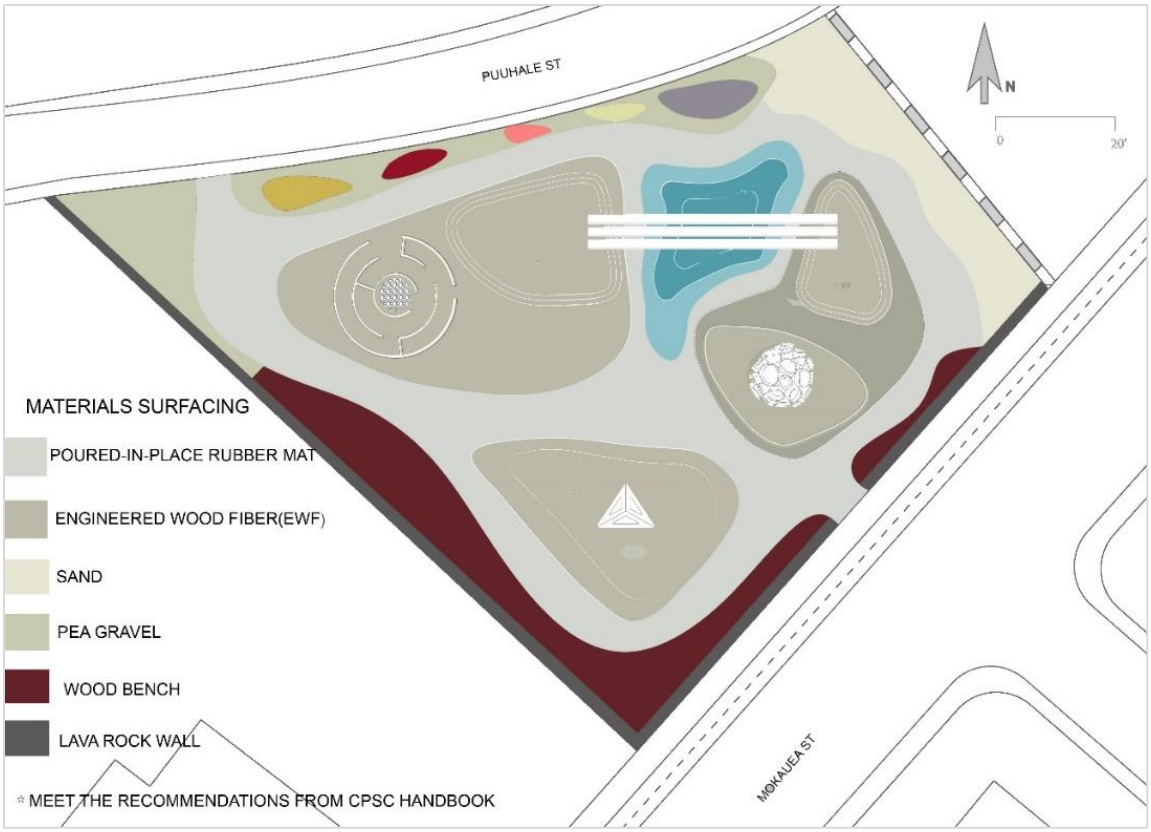


Figure 103. Materials Applied to Playground Layout.

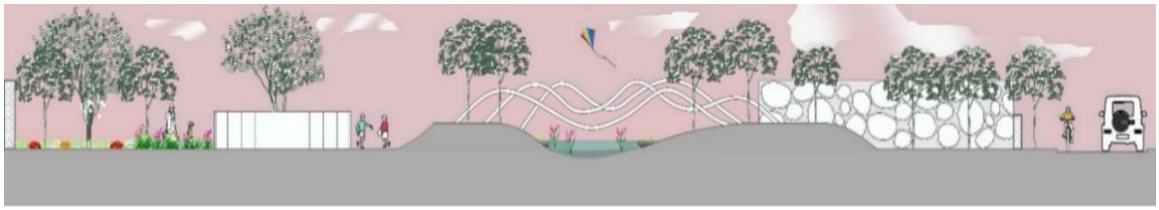


Figure 104. North Elevation of a Playground.

Figure 105. Playground Layout.

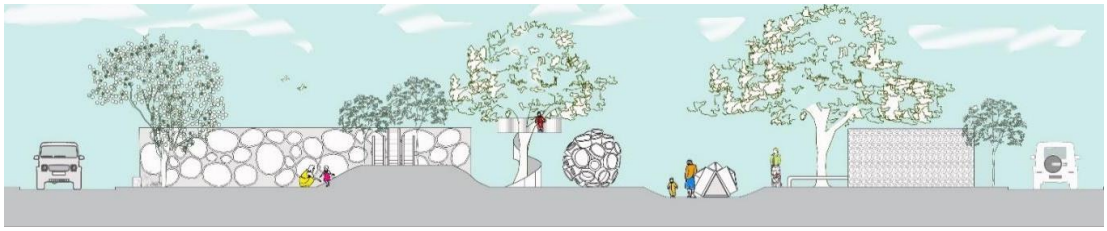


Figure 106. East Elevation of a Playground.

Figure 107. Conceptual Rendering of a Playground.

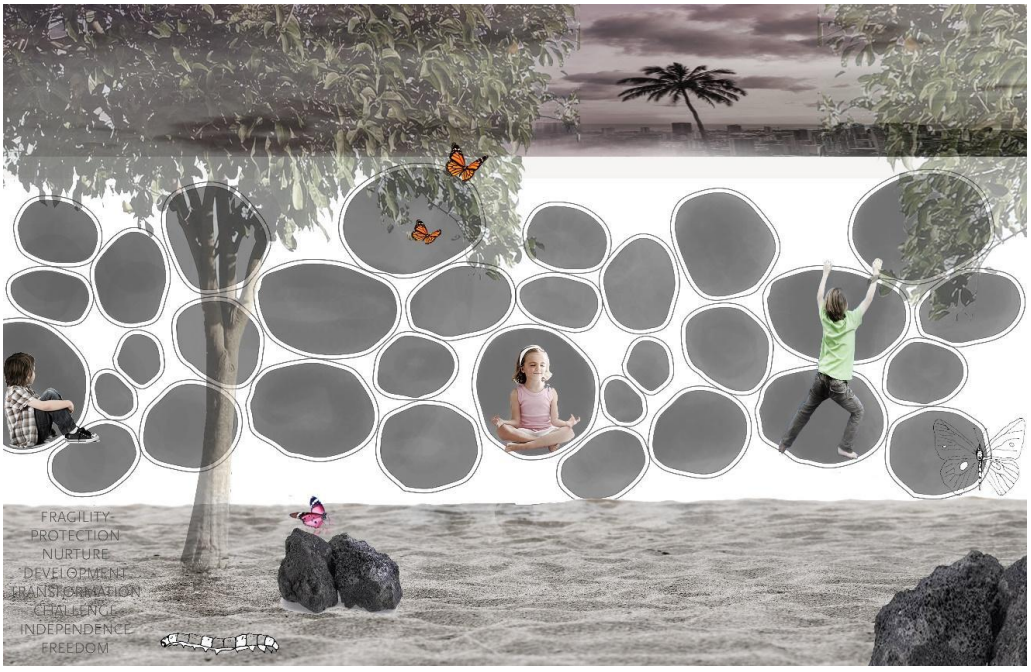


Figure 108. Conceptual Rendering of a Playground.

9 Chapter 9. Conclusion

This study provides an innovative design criteria by taking existing concepts regarding biophilic design and further applying them to the creation of contemporary urban playgrounds. Through the literature review, the Biophilia Hypothesis was used as a framework to demonstrate how essential contact with nature is for humans. The importance that contact with nature has on children's health, as well children's respective preference to play within natural environments were both demonstrated through empirical studies. The overview of playground design reveals that safety concerns became the predominant design guidelines, and, as a result, playgrounds today do not wholly support children's overall development as they were once envisioned. Biophilic design is then proposed as a hybrid approach and an alternative guideline to be applied to the design of urban playgrounds, as it will have greater benefit for overall childhood development and wellbeing. Due to the lack of green spaces in dense, urban areas, public or private vacant or underutilized lots, as available, are suggested as opportunities to establish spaces to create playgrounds for children to play in contact with nature, which would consequently make daily exposure to a natural setting more accessible for children who live in areas otherwise secluded from nature.

A closer look at children's preferred spaces to play helped to define which biophilic design principles were best suitable for applying within the design of a playground. Based on these observations, sixteen biophilic design principles were selected, analyzed, and applied in all design aspects (e.g. shape, material, and color) within the consideration of play elements, as well as the site and landscape design of a playground.

A dense, urban neighborhood in Honolulu was selected for an application of this study. Site selection criteria were established with the goal of facilitating children's access to the playground and to reach as many children as possible within a selected area. The design concept, which was inspired by the life cycle of a butterfly, helped to define separate areas for children based on age.

A matrix was used to define which biophilic design principle was most appropriate for each area of the playground. A master matrix was designed to evaluate the occurrence of each biophilic principle in each play element. This information helped to establish the location of each play element on a playground.

Biophilic design is a growing area of research. This project could be taken further with the application of additional biophilic design principles that were not explored in this research. In addition, the relationship between childhood development and biophilic design principles could be further investigated. Design professionals are encouraged to continue to explore this topic, as it offers endless possibilities on the application of biophilic design principles into all aspects of children's play element and play space design.

Although I encountered some difficulty during the site selection process, in the end, the selected site is viable for development because of its location, municipal classification and ownership. It is located in a dense, urban community that is municipally recognized as lacking green spaces, and the site itself is already a mini-park in need of revitalization. These conditions alone could perhaps serve reason for a municipal body to amend present zoning codes, and, when informed about the necessity for children's contact with nature, the city of Honolulu might also have room to see it outweigh some governmental safety guidelines.

Biophilic design has come to play a significant role in contemporary architecture, and those who are involved with the creating, building, and sustaining of communities can see the importance of its application within the design and the typology of playgrounds and the buildings that surround them. At certain points during my research, I found difficulty regarding the selection of the particular biophilic design concepts that would be the most appropriate for application within the design of a playground. However, the answer to this question came to me when I looked deeply at children's preferences regarding spaces to play. Perhaps it was not a coincidence that certain biophilic design principles (e.g. Risk/Peril, Refuge, Mystery, and Natural Elements) were also encountered in children's preferred spaces to play throughout decades past. Taking a risk is part

of biophilic design principles; in essence, it is something that is intrinsic within human beings as part of our evolutionary process.

By looking at the majority of public playgrounds in the U.S. today, one can imagine that the design of these playgrounds, although safe and colorful, might not provide the best opportunities for childhood development and social interaction as they once did. Consequently, children today have lost the opportunity to play in environments that wholly stimulate their overall development. Society is also withholding a chance to utilize public, often dense and urban, spaces to their entire potential, since this typology offers space for connecting communities and revitalizing underutilized urban areas.

Safety standards largely being used as foundation for playground design guidelines have led to excessively safe and consequently uninteresting equipment for play. While children's safety must not be overlooked, safety guidelines should not serve as the primary criteria for playground design, as safety is not the only thing children need so as experience the world around them. Children, while playing, must be able to explore their respective environments using their evolutionary instincts and experiencing all the natural world has to offer. Essentially, as with the movement of a butterfly through its life cycle from egg to flight, every child should be afforded the creative playground-based opportunity to challenge one's self so as to eventually be able to spread his or her wings and soar.

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Appendix

The CPSC Handbook

The U.S. Consumer Product Safety Commission's ("CPSC" or "Commission") Public Playground Safety Handbook was first published in 1981 under the name A Handbook for Public Playground Safety. The recommendations in the Handbook are focused on playground-related injuries and mechanical mechanisms of injury; falls from playground equipment have remained the largest single hazard pattern associated with playground use. Since the first edition, the Commission has included recommendations that playgrounds not be installed over concrete, asphalt, or paved surfaces to address serious head injuries due to falls from the equipment. Additionally, the Commission has made suggestions for commonly used loose-fill and unitary surfacing materials (e.g., wood mulch, pea gravel, sand, gym mats, and shredded/recycled rubber mulch) that provide head impact attenuation and can mitigate the hazard presented by falls from playground equipment. Maintaining the focus on falls, the Handbook's surfacing recommendations are based on the surfacing material's energy absorbing effectiveness.

The CPSC handbook includes specific recommendation for each stage of child development. It addresses the respective needs of toddlers (6 months through 23 months of age), preschool-age children (2 years through 5 years of age), and school-age children (5 years through 12 years of age). Children with different ages should have separate areas to play to reduce the chance of injury. The handbook assumes that there might be an overlap development pattern that happen for children with 2 and 5 years old. For example, a specification for an equipment designed for a two years old children might be used for a 3 years old children. The primary cause of injury across all age groups was detailed in a 2001 to 2008 study conducted by CPSC researchers. In this study, researchers surveyed 2,691 playgrounds and identified equipment related injuries, most of which were fall related.[194] While falls accounted for 44% of all playground injuries,

[194] O'Brien, Craig W.; Injuries and Investigated Deaths Associated with Playground Equipment, 2001–2008. U.S. Consumer Product Safety Commission: Washington, DC, October, 2009.

equipment-related hazards caused 23% of all injuries. Others hazard patterns that are considered common are related to collision (e.g., child to another child or child to equipment), entanglement with ropes or leashes, or impact from equipment tip-over or structural failure. The recommendations within the CPSC Handbook were meant to address potential hazards that could result in injuries or even deaths.

According to the CPSC handbook, the surfacing of a playground is a key factor to be considered in relation to individual's injury from falls and overall accessibility. The surfacing under and around playground equipment is the most significant aspect for the prevention of life-threatening injuries, specifically those involving the head. The CPSC considers the "critical height" as the "fall height below which a life-threatening head injury would not be expected to occur."[195] The ASTM F1292—the Standard Specification for Impact Attenuation of Surface System Under and Around Playground Equipment—provides the "critical height" rating of surfaces. The material surface and the height, where the equipment will be installed, should comply with ASTM F1292. There are two options of materials recommended by CPSC handbook for playground surface: unitary and loose-fill materials such as rubber mats, tiles, or materials with shock-absorbing properties. Unitary material is meant to be tested and approved under ASTM F1292 standards. Loose-fill materials are usually landscape (mulch) type of materials that can be applied to a specific depth but should be avoided for toddlers' playground areas because the risk of ingestion. Engineered wood fiber (EWF) is a wood product similar in appearance to landscape mulch, but it is specifically designed for playgrounds. Another option regarding loose-fill material that can be applied under or around playground equipment is rubber mulch that is designed specifically for playground surfaces. To be used as a playground surface, the respective material should be tested and must comply with ASTM F1292 for critical height-impacting attenuation. Recommendations that need to be applied for the installation of loose-fill material includes considering the relation to the "critical height"

[195] https://www.cpsc.gov/s3fs-public/325.pdf

rating of the surface material. This rating is meant to be greater than or equal to the fall height of the equipment (the distance between the equipment play level surface and floor surface) based on ASMT F1292 impact-attenuation testing.

Another aspect considered within ASMT F1292 is the minimum compressed loose-fill surfacing depths. The recommendation is to never use less than 9 inches of loose-fill material (except for shredded/recycled rubber that reaches 6 inches) and including a solid drainage system so as to maintain the loose-fill material in a place. In addition consider using loose-fill material that meets the ADA accessibility guidelines. Some wood mulch products contain chromate copper arsenate (CCA)—a toxic material that should be avoided. Some examples of appropriate surface materials described within the CPSC the handbook are pea gravel, sand, shredded/recycled rubber mulch, wood mulch, and wood chips. Some examples of inappropriate surface material are asphalt, concrete, dirt, grass, and CCA-treated wood.

The selection of the playground equipment should respect the age appropriateness of the children most likely to visit the playground, but it should also be attractive enough to stimulate children's development while encouraging them to take play-based risks. The design of the equipment should respect children's respective size, ability, and need based on the different phases of development. The openings of tunnels, for example, should be designed considered the potential for head entrapment; therefore, the scale of equipment and other design features should be based on the children's age. The installation and maintenance should also be considered, in addition to general hazards such as protrusion of bars, sharp edges, and crush/shear points—areas of potential harm caused by parts moving relative to each other or to a fixed part during a normal use cycle such as with a seesaw.

Adult supervision for children playing on any playground in any circumstance is highly recommended, and the CPSC handbook provides specific guidance to address such supervision.

The handbook recommendations are designed for various age abilities and needs with regards of the type, scale, and layout of equipment. Children's ages are aligned with distinct stages of development and, therefore, are associated with specific abilities and needs. Some specific equipment is not recommended by the CPSC handbook because it presents a significant risk of injury. They are, for example, trampolines, swinging gates, giant strides, climbing ropes (that are not secured at both ends), heavy metal, and multiple occupancy swings.

The CPSC handbook recommends using materials that, when exposed to sunlight, does not absorb heat so as to avoid the risk of sunburn for children playing on the structures. One example not recommended is metal for platforms, slides, or steps. When selecting wood products and finishes for playgrounds, the CPSC handbook recommend avoiding those treated with chromate copper arsenate (CCA) to reducing children's potential exposure to arsenic. In addition, wood products should be smooth to avoid splinters. Wood and metals corners should be rounded, and metal edges should have a round capping. Materials with sharp edge should be avoided.

Site selection is another key factor to be considered regarding the design of playgrounds. The CPSC Handbook provides specific considerations in relation to site selection, for example the travel pattern that children should follow when visiting the playground. The nearby accessibility should be free of any potential hazards (e.g., roads with traffic, lakes, streams, and cliffs), and some method to contain children within the playground should be provide (e.g., fences and walls). Sun exposure should be controlled in play areas to avoid excessive heat within equipment and excessive sun exposure for children. Proper slope and drainage should be considered to avoid rain-based washouts. According to the CPSC handbook, the layout of the playground should be designed so as to provide accessible surfaces for children with disabilities and should be in accordance with ASTM F1951.

The CPSC handbook provides general hazards recommendation for the design of playgrounds. Potential crush/shear hazards should be avoided. Projections on playground equipment should not be able to entangle children's clothing. Design of equipment that has ropes that are not secured at both ends should be avoided. To avoid head entrapment, the openings of structures such as tunnels should be greater than 3.5 inches and less than 9 inches. Angles between specific elements of playground equipment should be greater than 55 degrees. Sharp points, corners and edges should be avoided.

The handbook manual also recommends that platforms be flat and should be no more than 32 inches high because the fall height of a platform is the distance between the top of the platform and the cushioning surface underneath. The maximum high between stepped platforms varies depending on age. For toddlers, a 7 inches' platform is recommended. For preschool-age, recommendations are for 12 inches. And for school-age children (5 to 12 years old), an 18-inch platform is recommended. Guardrails and protective barriers prevent unintentional falls from the platform or a passage of a children. In addition, guardrails or protective barriers should be provided on elevated platforms, walkways, landings, stairways, and transitional surfaces. However, important to note is that there exists a specific height recommendation for each age.. Toddlers have respectively less coordination and balance; therefore, the minimum elevation recommended for guardrails and barriers increases for toddlers as compared to school-age children. The CPSC handbook establishes that access to playground equipment could be through ramps, stairways, climbing nets, ladders, or tire climbers.

The recommendations on the CPSC handbook in relation to the layout of the playground is described in relation to accessibility, age separation, conflicting activities, sight lines, signage and or labeling and supervision.[196] To avoid conflicting activity within a playground and prevent

[196] https://www.cpsc.gov/s3fs-public/325.pdf

injuries from collision, the CPCS handbook recommends that play activities should be organized into specific areas. The recommendation is that dynamic physical activities should be separated from more passive and quiet activities and equipment should be focused within a specific and predetermined zone. The fact that playgrounds should have designated areas for respective children's ages, the handbook recommends that parents and caregivers should be able to observe all areas of the playgrounds. The CPSC handbook recommends that playground should be designed to allow unobstructed vision from one area to another; therefore, parents or caregivers are able to have a better supervision of their children regardless of a child's age. In addition, is recommended that signals and labels are posted throughout a playground area to help guide the supervisors with the playground appropriateness.

In 1990, The Americans with Disabilities Act (ADA) approved the only national-mandatory rule that prohibits discrimination based on disability and defined guidelines that should be provided to facilitate access play equipment. In 2000, the U.S. Access Board published its official guidelines regarding play areas.[197] These guidelines were implemented as a law in 2010, and by March 15, 2011, all play areas throughout the entire U.S. were required to be in minimum compliance with these guidelines. According to the ADA, the Americans with Disabilities Act, discrimination on the basis of disability is prohibited by law.[198]

The ADA ensures, among other things, access to a given built environment for people with disabilities. Also according to ADA guidelines, accessible routes should be provided to ground-level and to elevated play equipment. The accessible route to any structure must connect to at least one ground-level play component of each respective type included in the overall design (e.g., for a variety of experiences such as rocking, swinging, climbing, spinning, and sliding). An accessible route must be provided for at least one-half of the elevated play structures. An

[197] https://www.access-board.gov
[198] https://www.ada.gov/

exception is provided for any ground-level play component if at least one-half of the elevated play components are connected by a ramp and at least three of the elevated play components connected by the ramp are contrasting types of play components. A transfer step to elevated play structures is allowed based on the number of elevated play activities. Surfaces on the way to, under, and around play structures must be cushioned to accept falls in a safe manner.

According to the study "Surfacing the Playground: 7 Things Every Playground Owner Should Know About Accessibility of Their Playground Surfaces," a publication of the U.S. Access Board and the National Center on Accessibility, the first element to be considered when designing a playground is comprehensive planning and site selection.[199] Comprehensive planning is related to the commitment to maintaining playground surfaces and playground equipment for their determined and respective lifespans, and a planning process is recommended as an essential to ensure that such commitment has follow-through. In essence, accessible site selection is recommended so children can have an accessible and inviting playground. The placement of accessible routes to reach all play equipment, general pedestrian routes, and points of entry and egress should be considered whenever designers move toward the creation of contemporary and thoughtfully constructed playgrounds. Another important recommendation is to follow the accessibility standards described by the ADA and the ABA. These standards do not require that the entire play surface area to be accessible to everyone; however, at least one connection—a point of entry and egress—to each play component must be provided. That being said, designing the entire play zone with wholly accessible routes for anyone who might like to play there is considered best practice.

The U.S. Access Board reviewed the research findings that were made by the National Center on Accessibility at Indiana University. For this study 35 playgrounds were analyzed and five

[199] https://www.access-board.gov

categories of surfaces were studied: poured in place rubber (PIP), tiles (TIL), engineered wood fiber (EWF), and hybrid surface (HYB). The conclusion demonstrated that no perfect playground surfaces existed among the ones reviewed in the study. Every type of surface demonstrated some type of issue over time. Another aspect considered within the study was access during the planning, installation, and maintenance of the respective playground so as to make sure that the slope and cross slope, both of which are significant for drainage, are adequate. In addition, a planning team is recommended to determine the most appropriate playground surface for their site. Lastly, the study recommends that proper installation of the equipment and ongoing maintenance be conducted to ensure continued compliance with the standards.

ADA: Playground Surfacing Materials ADA-Approved and Non-Approved by Mike Marshall On March 15, 2011 The U.S. DEPARTMENT OF JUSTICE 2010 ADA Standards go into effect with specific new sections that govern the design, construction and numbers of accessible elements in playgrounds. Section 240 of the 2010 Standards provides scoping for play areas and section 1008 provides the technical requirements. Section 240.1 of the 2010 Standards establishes play area requirements for children ages 2 and over and covers separate play areas within a site for specific age groups. Section 240.1 also provides four exceptions to the requirements that apply to family child care facilities, relocation of existing play components in existing play areas, amusement attractions, and alterations to play components where the ground surface is not altered. Section 1008.2.6 of the 2010 Standards provides technical requirements for accessible ground surfaces for play areas on accessible routes, clear floor or ground spaces, and turning spaces. These ground surfaces must follow special rules, incorporated by reference from nationally recognized standards for accessibility and safety in play areas, including those issued by the American Society for Testing and Materials (ASTM). ASTM code standards identify ways to test and compare surfacing materials. They do not identify specific materials; rather, they establish standards that must be met if the materials are to be used in ADA-compliant playgrounds. The selection of materials must be based on many characteristics of the individual

play areas: height of equipment; age of users; dispersion of elements; normal weather conditions; maintenance costs; installation costs; equipment life expectancy; and environmental concerns.

There are basically two options for ADA-compliant surfacing materials, loose fill materials or synthetic materials. The functionality of the different types of materials is the most significant concern for a school or public entity that is installing or upgrading a playground. When choosing between types of surfacing materials there are three criteria that must be used to assess functionality in an ADA-approved play area.

1. What is the force of impact from a fall in a use zone, in and around playground equipment? The code requirements are referenced and established by ASTM Standard 1292-99 and ASTM F 1292-04. These codes provide a uniform means to measure and compare characteristics of surfacing materials to determine whether materials provide a safe surface under and around playground equipment. These standards are also referenced when an accessible surface is required inside a play area use zone where a fall attenuating surface is also required. The standards cover the minimum impact attenuation requirements, when tested in accordance with Test Method F 355, for surface systems to be used under and around any piece of playground equipment from which a person may fall. Where are the accessible Routes located both in and around playground components and to and from playgrounds themselves? These requirements can be found in ASTM F 1487 and ASTM 1487-01, which establishes a nationally recognized safety standard for public playground equipment to avoid injuries identified by the U.S. Consumer Product Safety Commission. ASTM 1487 defines the use zone as the ground area beneath and immediately adjacent to a play structure or play equipment .Playground Surfacing Materials circulation around the equipment and on whose surface it is predicted that a user would land when falling from or exiting pertinent play structures or equipment. ASTM F 1487 identifies the play area standard when defining accessible routes, which overlap use zones that require fall attenuating surfaces. In short, if the use zone of a playground is not entirely surfaced with an

accessible material, at least one accessible route within the use zone must be provided from the perimeter to all accessible play structures or components within the playground.

These standards are addressed in ASTM F 1951-99. ASTM F 1951-99 establishes a uniform means to measure the characteristics of surface systems in order to provide performance specifications to be used when selecting materials for use as an accessible surface under and around playground equipment. Surface materials that comply with this standard and are located in the use zone must also comply with ASTM F 1292. The test methods in this standard address access for children and adults who may traverse the surfacing to aid children who are playing. When a surface is tested it must have an average work per foot value for straight propulsion and for turning less than the average work per foot values for straight propulsion and for turning, respectively, on a hard, smooth surface with a grade of 7% (1:14). Some of the surfacing materials do not meet the level of compliance for both impact attenuating surfaces and compaction for mobility devices that the standards address but the materials, when tested to the AMSE Standards; do meet the definition of the new regulations. Here are a few specifications and recommendations for the different types of surfacing materials. All loose fill surfacing requires daily raking to maintain the required depth of the material to ensure the safety of children. Replenishment is also required as loose fill gets packed down or kicked away. Often this type of maintenance does not take place, creating unsafe playgrounds. In addition, loose fill is often tracked into buildings requiring additional maintenance indoors. These are the most common types of loose fill:

> Pea gravel, sand and wood chips. These materials do meet compliance standards for impact attenuating surfaces, but they seldom meet the standard for propulsion and turning requirements in the ASTM standards and are not recognized as ADA-approved materials. Other surfacing materials can be used to create paths to the entry point of the play equipment and render your playgrounds compliant.

Pea gravel Pros:

The material is quite cheap and easy to maintain. It allows for good drainage and does not attract animals. Cons: It can be a hazard if it is thrown by persons in the playground and daycare providers have reported that pea gravel fits well in a nostril or an ear, which can result in an unwanted visit to the doctor or emergency room. It is creates a problem for maintenance of the grass and surfaces surrounding the playground. Lawn mowers can throw the gravel significant distances. The material cannot be used if the fall height within the playground is greater than 5 feet.

Sand Pros:

Sand is one of the easiest products to maintain. You just need to level out the sand if it gets windswept. Children love to play in sand. Cons: Cats often use the sand as a litter box—a health code concern. Broken glass and other debris can also become buried in sand and present other hazards. Furthermore, in freezing conditions, sand can become as hard as concrete and can only be used after the sun warms the surface or the materials are loosened manually. The material cannot be used if the fall height within the playground is greater than 4 feet.

Wood Chips (not engineered wood fiber) Pros:

This material is inexpensive, easy to find, and easy to move from place to place. It is also a good fall attenuating surface material. Cons: This material requires constant maintenance. It must be turned over occasionally to prevent decomposing, and wood chips do not have good drainage qualities. Moreover, about 25% of the material must be replaced annually. Wood Chips can be used for play structures with a fall height up to 10 feet.

Shredded Rubber and Engineered Wood Fiber Pros:

Both of these products are ADA-approved for both mobility and impact attenuation. That is not to say that they are extremely functional as a solid surface material, but they do

meet the minimum requirements of ASTMF 1292. And other surfacing materials are not required to create circulation paths. They are also cost efficient. Cons: These materials have the potential to off-gas in high temperatures. They are also difficult to keep in the play areas, out of the grass, and out of children's clothes. Shredded Rubber and Engineered Wood Fiber can be used for play structures with a fall height up to 10 feet.

Fully Accessible Surfaces

Pour-in-Place, Rubber Mats/Tiles

Pros:

These artificial surfacing materials exceed ADA standards and are deemed universally accessible for children with disabilities. The most significant benefit of these surfaces, other than accessibility, is that daily maintenance is usually not required to ensure that safety is maintained. Generally, relatively little effort is required to keep the surfacing materials safe and usable, in normal use zones. If the materials are installed on a grade with no place for water to puddle, the surface of the mats and tiles will not freeze causing the outer layer to break away. This can cause for expensive and time consuming repairs.

Cons:

Over time tile edges turn up, creating a trip hazard. Expansion between tiles also allows materials to accumulate, and the surface of the pour-in-place materials can freeze and separate. Consequently, it is difficult to patch the surface for an extended period of time. The biggest problem with these surfaces is the cost, which is significantly more than loose-filled surfacing. Lastly, the average life expectancy for the pour-in-place materials is usually much less than advertised, as weather conditions are a significant factor in the life of this type of surfacing material. While products differ in quality and density, the average pour in place product can provide an ASTM safety rating for fall heights up to 12 feet.

Artificial Grass with Rubber "In-fill".

Pros:

A properly certified turf should also have a soft, consistent surface that is ADA accessible for easy wheelchair access. Since the grass won't displace like loose fill, such as sand, rubber chips, or wood chips, the safety rating is easy to maintain, even under play equipment. Moreover, a synthetic grass playground surface that is certified by IPEMA provides independent verification that the product has met a rigorous set of industry standards.

Cons:

The greater issue with these surfaces is the cost, which is significantly more than the costs of loose filled surfacing; however, they are an excellent choice if the accessibility of the surface is as important as the functionality. Lastly, artificial Grass with a rubber infill is significantly more expensive than loose fill materials, but is usually less expensive than pour-in-place surfaces. • Artificial grass installed over a proper base can provide an ASTM safety rating for fall heights up to 12 feet. Page 3 - Playground Surfacing Materials All surfacing materials have advantages and disadvantages. The purchaser and the installer must ultimately assess the safety factors that will influence the type or types of playground surfaces to be used. Among those factors are the location of the playground; drainage potential; average grade of the surrounding area; cost of installation and maintenance; life expectancy of the surface and infill materials; accessible routes to the playground; ambient temperature of the environment; security for the playground; amount of use; ages of the users; height of equipment; and amount and dispersion of accessible elements. To provide a safe and accessible playground that is consistent with the new 2010 Standards for Accessible Playgrounds, all of these factors should be reviewed. While expense is a primary concern for the school, park or city that is investing in a new playground, it cannot be the only limiting factor according to the ADA. Remember, safety, accessibility, and user integration are equally as important.