ABSTRACT

Title of Document: RETHINKING PLAYGROUNDS: A DESIGN INVESTIGATION OF PLAYSCAPE THEORY

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This thesis will study how playscapes and nature play offer alternatives to traditional playground designs by encouraging multiple facets of childhood development. Playscapes promote play spaces that integrate physical, mental, and educational features. Harnessing the malleability of the natural landscape provides clear developmental advantages that surpass traditional structure-based playground design and provide opportunities for building environmental literacy. After combining research with feedback taken from site users, a design will be proposed for the exterior of Riverdale Elementary School, in Riverdale Maryland. Anacostia Watershed Society has received a grant for implementing stormwater controls and improving the quality of the nearby Wells Run stream. The design of this project will show how it will be possible to combine playscape, nature play, and environmental literacy goals with stormwater storage and treatment to transform the school's environment.

RETHINKING PLAYGROUNDS: A DESIGN INVESTIGATION OF PLAYSCAPE THEORY

By

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Chapter 1: Literature Review

Children and Nature

In the last century a major societal shift has taken place affecting the play behavior of children at all ages (Louv, 2005). A typical child's exposure to nature has decreased, both in the amount of time that child would spend in those environments and also the size and scale of outdoor spaces that are available to them (Spencer & Woolley, 1998). Causes for this change include the increased urbanization of our country. With the majority of our population now living in dense urban environments the adoption of automobile culture has crisscrossed our landscape with places dangerous for children and exploration. "Urban areas — defined as densely developed residential, commercial and other nonresidential areas -- now account for 80.7 percent of the U.S. population" (Census, 2014). Popularized in Richard Louv's book Last Child in the Woods, this phenomenon has begun to be documented anecdotally. Parents, caretakers, and education professionals all report witnessing this shift in play behavior and have started linking negative behavioral ramification to the change, including physical and emotional health problems. Social scientists have begun to take notice, and in the last few decades a new area of research has emerged studying these claims in order to provide empirical data justifying the call to work towards providing natural green play spaces for children.

Nature Deficit Disorder

Consequences of removing access to nature for children affect all aspects of their development. According to Moore and Wong (1997), active learning in outdoor settings stimulates all aspects of child development more readily than indoor environments. Play theorists have broken down the developmental effects of outdoor space into three main categories, Physical, Cognitive, and Social (Herrington et al, 1998). An example of physical effects includes removing larger scale play spaces and in some cases, motivation to explore those play spaces. This disincentives children to be more physically active and may lead to sedentary lifestyles or may contribute to the obesity epidemic. Dyment, Bell, and Lucas' 2009 study of schoolyard greening and physical activity intensity shows for example that paved sports areas have the highest percentage of sedentary activity on a playground. Natural play spaces often provide a variety of physical structures allowing for a spectrum of movements. A cognitive effect is shown where time spent in or even visual access to green space has been shown to alleviate stress and the symptoms of ADHD, so it is possible that taking children out of these environments makes those symptoms worse (van den Berg, 2011). Outdoor spaces provide psychological benefits as well, allowing children to learn to explore, take risks, and manipulate malleable environments of different scales. Some important developmental concepts have arisen out of outdoor play research and should be defined here:

Affordance – Psychologist James Gibson theorizes that our perception of our environment is crucial in our understanding its functions. According to the theory affordances, or clues in the environment that indicate possibilities for action, are perceived in direct, immediate ways with no sensory processing. Exposure to varied environments, including nature, is therefore important for teaching children the processes that surround them (Gibson, 1979).

Territorial range – The spatial area that encompasses a child's play and leisure spaces and the pathways connecting them. In 1986 Robin Moore defined the term in relation to children and proposed that as children age their range should be given the opportunity to expand, and that the borders should be flexible to allow for exploration.

Loose Parts – Term coined by Simon Nicholson suggesting that when children are given a wide range of materials that have no defined purpose, they will be more inventive in their play and have infinite play opportunities. "In any environment, both the degree of inventiveness and creativity, and the possibility of discovery, are directly proportional to the number and kind of variables in it" (Nicholson, 1971).

Attention Restoration Theory – Developed by Rachel and Stephen Kaplan, the theory proposes that both children and adults have an increased ability to concentrate on tasks after spending time in nature. The theory divides attention into to subtypes, voluntary (requiring directed effort) and involuntary (constantly active). Exposure to nature is typically involuntary, giving one's directed, voluntary attention a chance to 'rest' (Kaplan, 1989).

An example of a social effect is that outdoor play spaces provide advantages that indoor play does not. Place-making, an important part of creating a social and cultural identity can be enhanced by providing children with attachments to the outside world and a chance to manipulate that world, taking ownership of parts of it. Having an established school ground culture "fosters positive social dynamics and provides opportunities for non-competitive, open-ended play and stewardship" (Bell & Dyment, 2007). Outdoor play also assists social development by providing opportunities for education.

Environmental Education

Environmental education can foster this sense of social responsibility by providing exposed process education, illuminating natural processes such as the water cycle or the origins of our food that are often hidden in our modern world. Malone and Tranter suggest a number of ways in which school grounds can be enhanced to provide spaces for natural learning (2003). Outdoor spaces can also provide areas that enrich typical environmental curriculum, providing Biology, Ecology, and many other science classes with experiments.

Simply being able to viscerally see and touch what they are learning about in class helps keep children interested and motivated. Environmental Literacy is a recent addition to many educational programs, including having newly created regulations on State and National levels that help guide environmental literacy growth by providing goals and benchmarks for sites and programs involved.

Green Ribbon Schools

The Green Ribbon Schools award is given to select schools across the nation that The U.S. Department of Education recognizes as schools that save energy, reduce costs, feature environmentally sustainable learning spaces, protect health, foster wellness, and offer environmental education to boost academic achievement and community engagement. Schools are recognized with the award if they have achieved or are making demonstrable progress toward three 'pillars' of sustainability.

1. Having a net zero environmental impact

   Reducing or eliminating greenhouse gas emissions, using energy or emissions reduction plans, improving water quality/conservation, reducing solid and hazardous waste production, and expanding use of alternative transportation through locally available, energy efficient options.

2. Improving the health and performance of students and staff

   Having an environmental health program integrated into the school including safety and maintenance, promoting high standards of nutrition, fitness, and quantity/quality of outdoor time for both students and staff.

3. Ensuring the environmental and sustainability literacy of students

   Interdisciplinary learning about relationships between environmental and human systems, use of the environment to develop STEM content knowledge, development of civic engagement skills to address sustainability and environmental issues.

Environmental Literacy Standards

The North American Association for Environmental Education has constructed national frameworks for each individual state to construct their own environmental literacy plans. That framework defines their goal by stating "an environmentally literate person is someone who, both individually and together with others, makes informed decisions concerning the environment; is willing to act on these decisions to improve the well-being of other individuals, societies, and the global environment; and participates in civic life." The Maryland Environmental Literacy Standards represent the knowledge and skills relating to the environment that students will have upon graduation from a Maryland school system. Addressed through a variety of courses, service learning, and classroom and outdoor experiences from Grades PreK-12, the standards are divided into eight categories:

1. Environmental Issues
   Identifying and investigating issues and action components
2. Interactions of Earth's Systems
   Analyzing the Earth's systems and learning systems thinking
3. Flow of Matter and Energy
   Conservation of matter, energy distribution, biospheres
4. Populations, Communities and Ecosystems
   Matter and energy cycling, population, community, and ecosystem dynamics
5. Humans and Natural Resources
   Human impact on natural resources and processes
6. Environment and Health
   Natural changes, human-induced changes and health, risk analysis
7. Environment and Society
   Cultural perspectives, political systems, economics and technology
8. Sustainability
   Intergenerational responsibility, interconnectedness, social and cultural systems, limits of systems and action components

History of Designed Play Spaces

As more parents and educators accept the incredible importance of allowing children access to nature, it becomes paramount that we provide that access to children during their daily lives. Historically, designed spaces for children began as spaces reserved for play. Creating spaces specifically designed for play is a relatively new human phenomenon closely linked with the emerging prevalence of urban living. The first playground in the United States was opened in San Francisco's Golden Gate Park in 1887. It was part of a government funded project to create public spaces, within which President Theodore Roosevelt recognized the need for play areas. He stated "City streets are unsatisfactory playgrounds for children because of the danger, because most good games are against the law, because they are too hot in summer, and because in crowded sections of the city they are apt to be schools of crime. Neither do small back yards nor ornamental grass plots meet the needs of any but the very small children. Older children who would play vigorous games must have places especially set aside for them; and, since play is a fundamental need, playgrounds should be provided for every child as much as schools." Organizations such as New York City's Outdoor Recreation League advocated for an increase in play areas for children in cities, and the Playground Association of America was created in 1906 to begin to build playground for schools around the country. Playground began as elaborate sand boxes, or 'sand gardens,' providing space for children who were unable to safely (or legally) play in urban streets. Over time the structure of playgrounds has evolved through visible stages. Dr. Joe Frost has identified the major shifts in playground design thinking over the last century, outlined here:

- 1880s-1890s: Sand Gardens.
- 1900s-1920s: Model Playgrounds.
- 1930s-1940s: Development slowed or suspended due to depression and war efforts.
- 1940s-1950s: Adventures or Junk Playgrounds.
- 1950s-1970s: Novelty Playgrounds.
- 1970s-1980s: Standardized Playgrounds.
- 1980s-present: Modern Playgrounds.

Model playgrounds took the sand gardens and added the elaborate play structures that gave playgrounds the form we associate with them today. It was the adventure playground movement however that really began to question the developmental needs of children and design accordingly. Centered in Europe, adventure playground thinking suggested that children themselves should have a larger hand in controlling their own play. They should be allowed to harness their creativity by having complete access to 'loose parts,' building materials or junk they could build with, manipulate or destroy without restriction. These playgrounds included 'play leaders' that would supervise the children, but primarily they were let loose to grow and explore at their own pace. While there are a rare few adventure playgrounds in America, most of our play spaces were built with the designs concentrating on the play structures. Novelty playgrounds were areas where space-age construction or animal-shaped play sculptures took precedence, correlated in part with the rise in popularity of amusement parks. This shifted into our modern era with a new concentration on safety, with the standardization of safety rules and regulations beginning to dictate playground materials, construction, and design (Frost, 2012). A new emphasis on child psychology has also led to the current philosophy of playground design, a philosophy of synthesizing play, health and learning within one play landscape. "This [older] `place-less' equipment-based approach to designing playgrounds does not speak to the qualities of being outdoors….Children's social, emotional, and cognitive development must also be considered" (Herrington et al. 1998). By 2012, "integrated" playgrounds or playscapes were expanding, buoyed by research and experience on the value and processes for integrating built materials, habitats, gardens, tools, junk, wild places, nature areas, and indoor/outdoor experiential learning into schools, neighborhoods, and cityscapes. Playscape philosophy is combining the ideals of the adventure playground movement with modern, up to date developmental psychology and an appreciation for interaction between children and nature.

Playscapes

Playscapes are the ideal form for incorporating the nature play movement into our country's evolving play culture. The most successful playscapes built at this time have incorporated some or all of the research and theories above into their designs. This thesis will look at two case studies, describing how they merged those philosophies into buildable physical forms.

Marge and Charles Schott Nature Playscape

Figure 42 Marge and Charles Schott Playscape Element

The Marge and Charles Schott Natural Playscape (MCSNP) is a superb example of a larger scale playscape design. At 1.6 acres, the playscape is as much a park as it is a playground. The playscape opened in 2011 as part of a partnership between the Cincinnati Nature Center and the NC State University Natural Learning Initiative. The grounds provide a dedicated space where children can wander 'off the trail' and engage in natural adventures in contrast to the strict rules present in the remaining 1000-acre nature preserve. Deliberately avoiding typical playground equipment, the playscape provides children with a variety of physical landscapes to explore, including stacked local rocks that create climbing and crawling structures. Some of its spaces include a variety of loose part settings, including dirt, sand, and pebble play, as well as fallen logs. Multiple environments are available for the children to explore including forest and field habitats designed to showcase seasonal plant textures and colors as well as a recirculating stream. The MCSNP has stated that its goals for children are to "facilitate child initiated learning; encourage curiosity, exploration and discovery; motivate physical activity; stimulate creativity; facilitate social interaction and respectful behavior; and to prompt

Figure 43 Marge and Charles Schott Playscape

decision making to test limits and become confident." The Site Plan shown above showcases some of the themed areas available for exploration.

A playscape at this size comes with specialized requirements however. The MCSNP seasonally employs a full time gardener to manage the grounds, as well as accepting maintenance from Nature Center facilities staff. Volunteers help with that upkeep as well as providing occasional coached play opportunities for children. One important goal of the organization is to convey to visitors the notion of personal responsibility for assessing risks. Helping them not to assume that everything must be safe and therefore no thinking is required on their part requires an active role in introducing visitors to the space.

Figure 44 Playscape Visitors

Brent Elementary School

Figure 45 Brent Elementary School Entrance

Brent elementary, located in Washington, D.C. is a compatible example of smaller scale educational campus greening that has many parallels to the potential of local Maryland school sites. The project transformed a typical asphalt and hardscape school exterior into a "model learning environment for students, teachers and parents." The project concentrated on encouraging students to spend time outdoors while in school by enhancing the available outdoor space with nature play and green space. The project hit three key categories of green renovation; creating learning opportunities and out of classroom experiences, increasing health through physical activity, clean air, and shade, and enhancing environmental performance and stormwater management. The project replaced 1,600 square feet of asphalt with pervious surface and rain gardens and created 7,000 square feet of outdoor education space.

Figure 46 Brent Elementary School Yard

Beyond expected amenities such as interpretive rain gardens and interactive butterfly gardens, the project also pioneered the use of child-scale educational green roofs. The green roofs are built on small structures that allow them to function while remaining visible and accessible to students who can then learn how they function and study their effects unlike typical green roofs that are inaccessible by children. Acknowledging the connections between these renovations and core curricula, the school implemented training for teachers and faculty to become proficient at explaining and in some cases maintaining the grounds, and also provided the teachers with books for the library, educational modules highlighting outdoor education, and a number of interpretive displays, brochures, and maps to guide students and visitors around the school. The Brent Elementary greening was possible only through a collaboration of designers, parents, stakeholders, and grant funding. It should be

Figure 47 Brent Elementary Green Roofs

held as an example of the success of systems already in place to compile the resources to create functional nature play and education projects on small-scale school sites.

While the lessons learned from these projects are important, in order for playscapes to become common throughout our communities there needs to be evidence that their design logic can be applied locally to smaller scale projects. Many neighborhood scale landscapes could benefit from having playscapes installed. Public parks often have spaces designated for children, some design spaces with nature integration in mind. Childcare centers and health centers both also often provide play spaces for children that could be modified into playscapes. Nature centers are a public space that often targets adult populations, by providing playscape areas they can get children interested in learning through play. Schools however have the distinct advantage of reaching a large, permanent audience of children on a daily basis. Their connection to Environmental Education can be worked into many aspects of the curriculum, and schools are already required to provide outdoor play for children. Many schools in disadvantaged communities have aging infrastructure that includes their outdoor play spaces, making them perfect candidates for a renovation. These schools can begin to serve as flagship projects for their larger communities, showing the advantages of creating outdoor play spaces, raising the value of that school system, and encouraging others to adopt similar practices.

Riverdale Elementary School

Riverdale Elementary School in Riverdale, Maryland is one such example. The school has play spaces that have been neglected over the time since the school's construction. As part of a lower income community the school system has not had the resources to update that landscape. Because of its proximity to the Wells run stream, recently the school has been accepted to receive a grant allowing it to perform a number of Stormwater retrofits. The school is partnered with the Anacostia Watershed Society and Biohabitats who currently plan a project that includes stream restoration work and designing a constructed wetland on the property adjacent to the school, and well as retrofitting the school and its surroundings with stormwater management systems. As part of the goal of providing visibility to natural processes (Stormwater runoff and its effects) and protecting the stream, a playscape can be designed to fit within the new school design.

The goal of this design project then will be to utilize this opportunity and design a playscape for Riverdale. Creating a site specific design will test the ability for current child nature play theory to be applied on a small scale. The project will take that knowledge into consideration and develop physical structures that promote the activities and theories the literature deems important for developmental growth. It will construct spaces that provide environmental education benefits, both tied into the school curriculum and the state and national environmental literacy standards. It will attempt to connect the schoolyard with the stream restoration and constructed wetland project, highlighting the exposed processes as part of a complete nature education. Finally, it will consider management, realizing that green play spaces have different safety and upkeep considerations than a traditional playground, especially when taking into account natural materials, vegetation, and water. This is an important project for the students of Riverdale, improvements to their school landscape will inspire confidence in their surroundings and themselves, and allow them opportunities to learn and explore nature.

Chapter 2: Site Inventory

Riverdale Elementary School

Figure 48 Riverdale Elementary Entrance

Riverdale Elementary School is located at 5006 Riverdale Road in Riverdale, Maryland and headed by Principal Cheryl Hughes. It is a public school and part of the Prince George's County Public School System (PGCPS). The school operates with approximately 760 students in grades K through 5.

The focus of the school's education programming is on building literacy, defined as the ability to read for knowledge, write coherently and think critically about printed material. Literacy is the key skill that allows students 'many opportunities to apply their knowledge to real-world situations.' Beyond that focus, the school has produced a mission statement:

"The mission of Riverdale Elementary School is to promote a risk-free environment that will nurture, shape, enrich and develop young minds to achieve their highest level of academic performance. We strive to empower students to be productive citizens and to foster success, respect, and appreciation of cultural diversity. We will involve parents, community, and staff in working towards a common goal for creating a love for life-long learning."

Demographics

Riverdale's estimated 2013 population was 7,147.

As a general trend, Riverdale is less well-off socio-economically than the Maryland demographic average. Incomes are lower, residents are less educated and less own their homes. Some of this may be due to a low education rate, indicating providing resources for schools would present an opportunity for education to be impactful in raising economic well-being, especially with a population comprised of more young people than the state average. A significant amount of the population was not born in this country, and an above-average number of residents speak a language other than English at home. Multi-cultural approaches to education should take into consideration the high population of Hispanic and Latino residents, as well as the above average population of American Indian / Alaskan Natives.

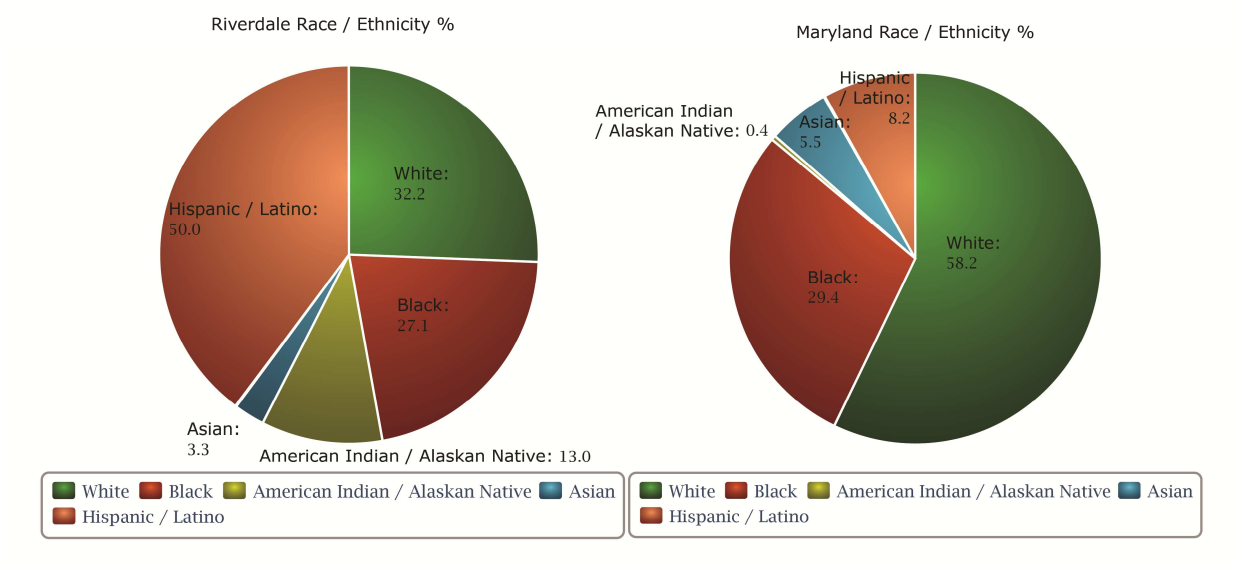


Figure 49 Riverdale Elementary Demographics

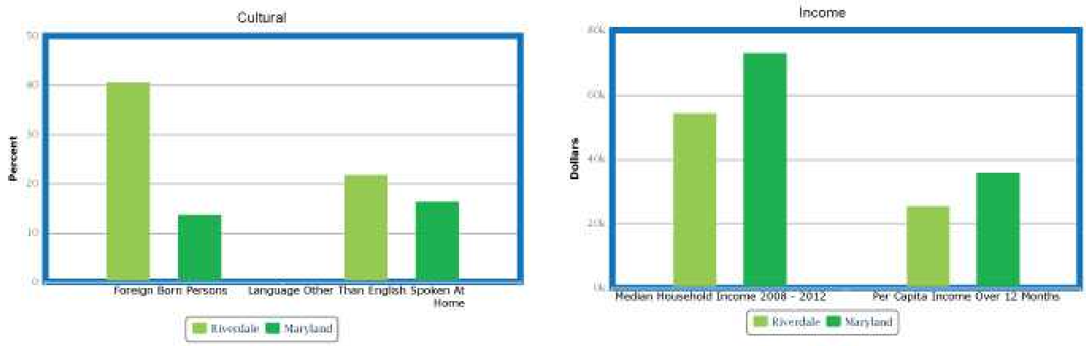


Figure 50 Culture and Income Comparisons

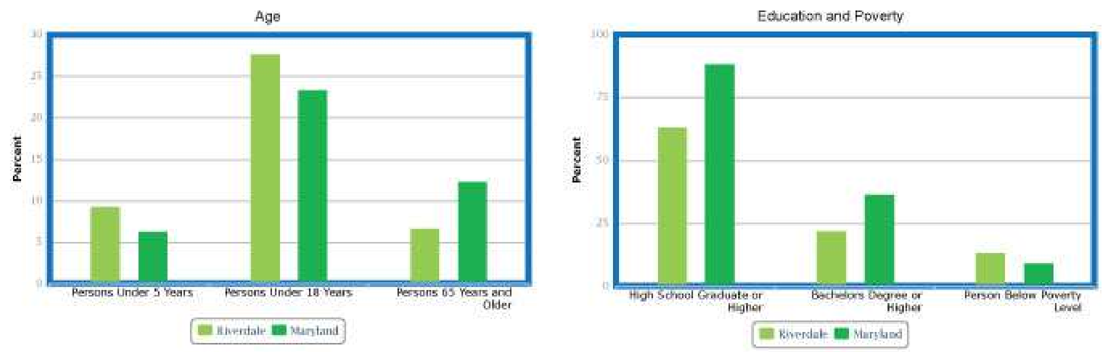


Figure 51 Age, Education, and Poverty Comparisons

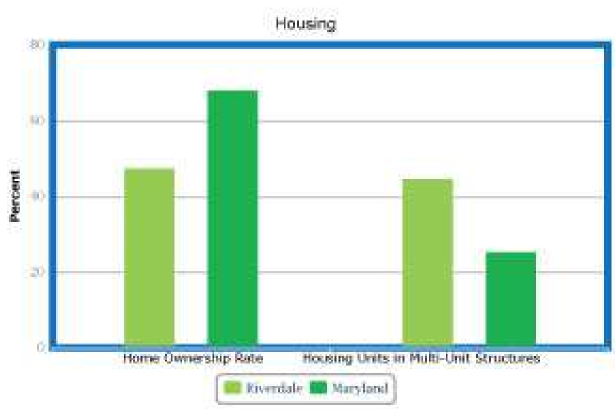


Figure 52 Housing Comparisons

Local Zoning

Figure 53 Zoning Map

R-O-S Reserved Open Space - Provides for permanent maintenance of certain areas of land in an undeveloped state, with the consent of the property owners; encourages preservation of large area of trees and open space; designed to protect scenic and environmentally sensitive areas and ensure retention of land for nonintensive active or passive recreational uses; provides for very low density residential development and a limited range of public, recreational, and agricultural uses

R-55: One-Family Detached Residential - Permits small-lot residential subdivisions; promotes high density, single-family detached dwellings.

R-18: Multifamily Medium Density Residential - Provides for multiple family (apartment) development of moderate density; single-family detached; single-family attached, two-family and three-family dwellings in accordance with R-T Zone provisions; Detailed Site Plan approval required for multifamily and attached dwellings.

R-10: Multifamily High Density Residential - Provides for suitable sites for high density residential in proximity to commercial and cultural centers; also permits single-family detached dwellings.

The site is zoned R-55 and R-O-S. While R-55 is comprised mainly of high-density single-family detached units, other allowable uses include educational facilities so that the school's presence does comply with zoning regulations. The Eastern edge of the site is Reserved Open Space, so that designs along Wells Run must avoid any permanent structures or uses that do not comply with the intention of preserving open environmentally sensitive areas.

Soils

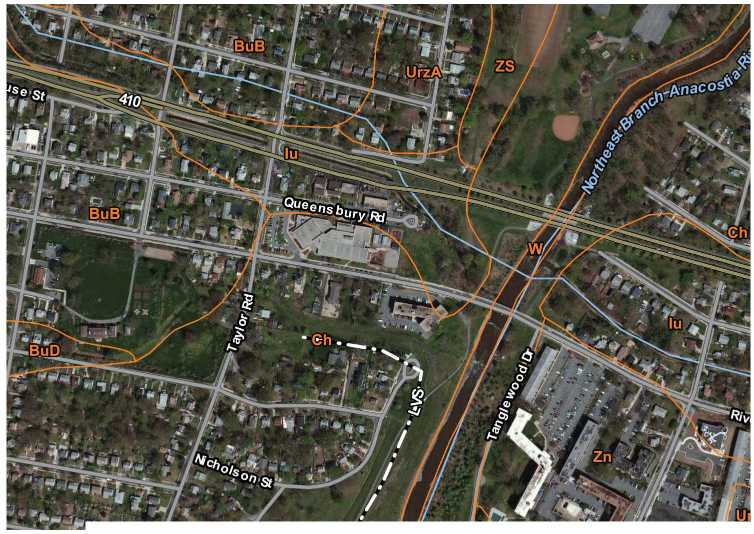


Figure 54 Soils Map

The site is primarily comprised of Codorus-Hatboro-Urban land complex and Issue-Urban land complex. Due to the proximity of the Wells Run stream the ground is consistently flooded, more for the soils closer to the banks. The soils are poorly to somewhat-poorly drained. Hydrologically Iu soils are rated C and Ch soils are rated D.

Map Unit Legend

Prince George's County, Maryland (MD033)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BuB	Beltsville-Urban land complex, 0 to 5 percent slopes	36.6	20.9%
BuD	Beltsville-Urban land complex, 5 to 15 percent slopes	2.0	1.2%
Ch	Codorus-Hatboro-Urban land complex, frequently flooded	74.2	42.3%
Iu	Issue-Urban land complex, occasionally flooded	30.1	17.1%
Un	Urban land	0.8	0.5%
UrzA	Urban land-Zekiah complex, 0 to 2 percent slopes, frequently flooded	7.1	4.1%
W	Water	4.8	2.7%
Zn	Zekiah-Urban land complex, frequently flooded	16.5	9.4%
ZS	Zekiah and Issue soils, frequently flooded	3.4	1.9%
Totals for Area of Interest		175.5	100.0%

Table 7 Soils Table

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Vegetation

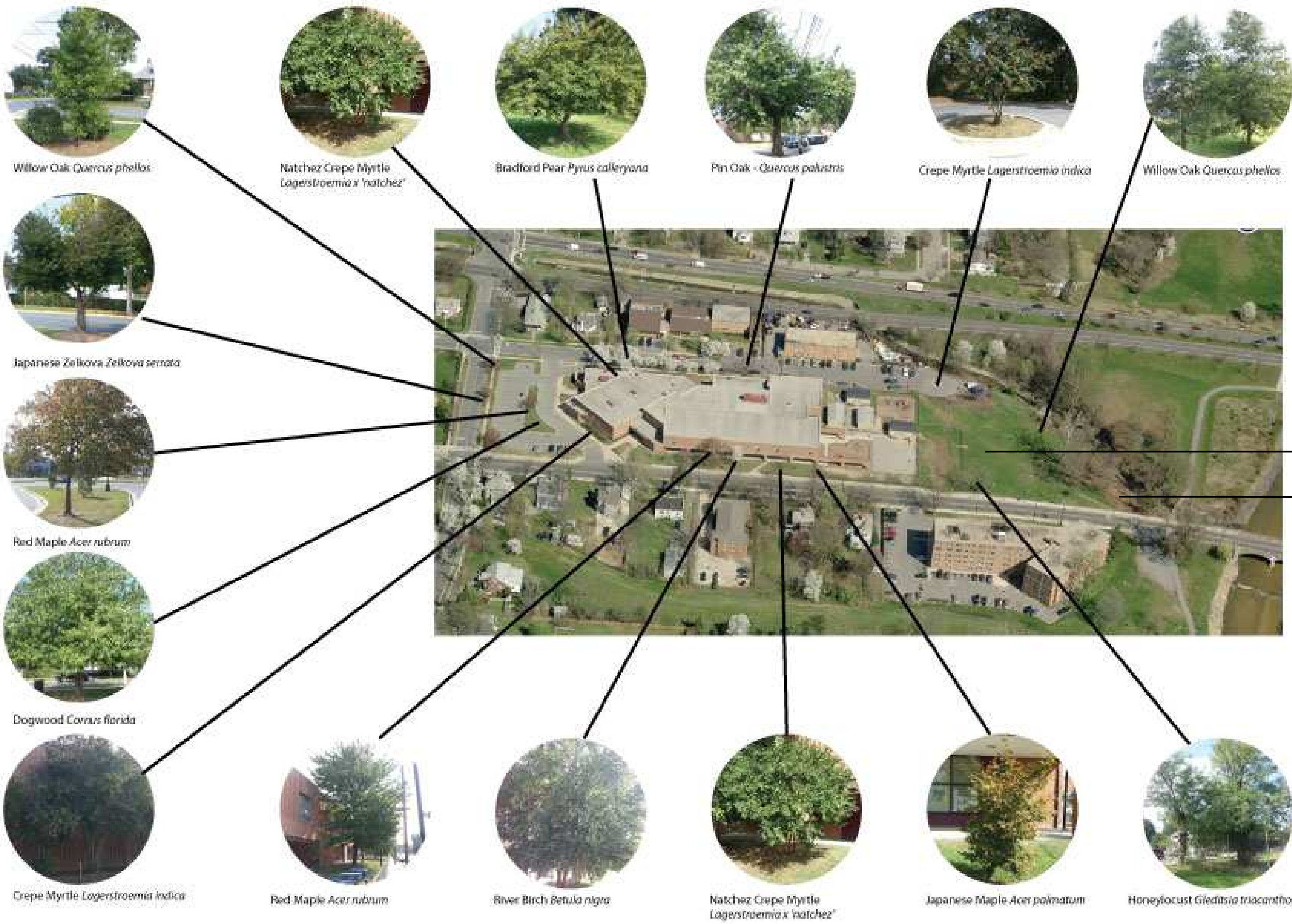


Figure 55 Vegetation Map

Vegetation surrounding Riverdale Elementary school is primarily comprised of street tree plantings. The school grounds have very little understory, shrubs, or groundcover plantings excepting close cropped lawn. Multiple red maples, the river birch, and willow oaks are in good conditions and should be preserved. Some ornamental trees such as a number of crepe myrtles are also in good condition. The crepe myrtles are however planted very densely along one edge of the school, it may be prudent to remove a small number to allow the others room to grow and to take back some important wall space along the entrance of the school. Other street trees have been severely pruned for overhead wires and may be in poor condition and warrant replacing, as do the line of Bradford pears which are highly invasive. Along the Wells run stream is a forest edge with a mixture of beneficial native trees and understory along with some invasive plants, including a large amount of 5-leaf Akebia. Assuming the site boundaries remain constant, a maintenance strategy should be considered that prevents encroachment by these areas. Outside the school's fence line a wet meadow has been planted in a bioretention area that seems to be healthy, though not well maintained.

Figure 56 Bradford Pear *Pyrus calleryana*

Figure 57 5-Leaf Akebia *Akebia quinata*

Hydrology

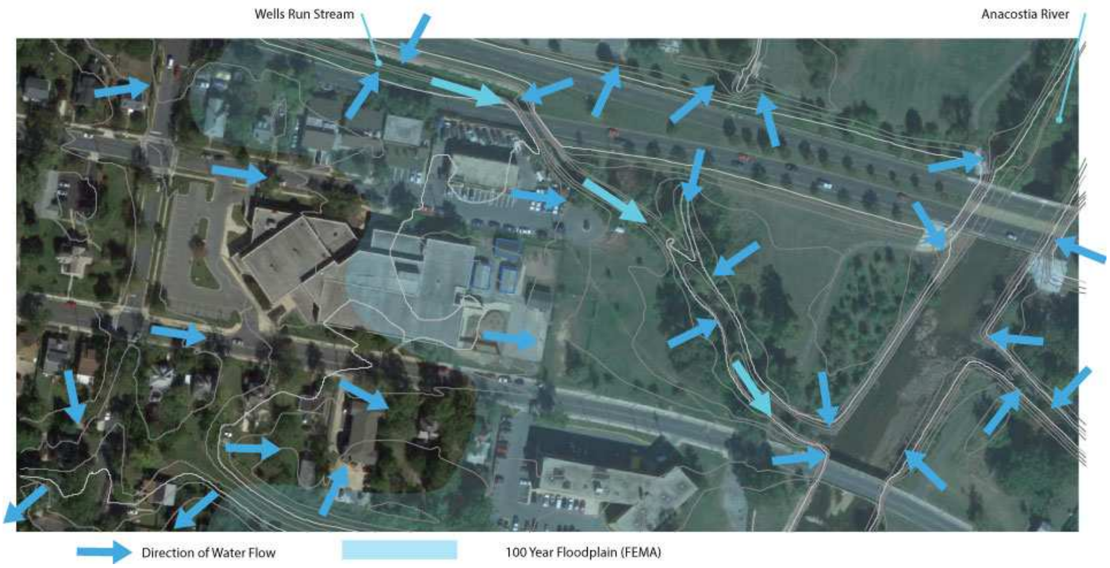


Figure 58 Hydrology Map

Water flow follows a fairly simple pattern across the site, traveling from the higher elevation on the Western side of the watershed towards the Wells Run tributary and then into the Anacostia River. Roads were either built on or have created ridges that tend to split water flow direction. Due to its proximity to the Wells Run tributary of the Northeast branch of the Anacostia River, the site is located on the border of the river system's 100 year floodplain. Building any additional permanent structures inside this zone should be done with awareness of this fact, as well as referencing soil data shown elsewhere in this document. Plantings will also need to address issues of periodic flooding, which may increase in regularity as climate change affects river levels during storm events.

The site has a substantial amount of impervious surface between parking areas and the building's roof footprint. Mitigating the pollutants from the surrounding roadways and slowing the speed of stormwater runoff will have to be done around those impervious surfaces, unless any redesign of parking or sidewalks can be justified that could then be replaced with pervious pavers or aggregate.

Environmental Connections

Riverdale elementary, represented on the lower left map by a blue circle, is located on an environmentally sensitive site within the greater Anacostia watershed. The Paint Branch, Little Paint Branch, and Beaverdam Creek all converge into the Northeast branch of the Anacostia before reaching the site. Any stormwater collected into the Wells Run therefore will affect a major regional waterway. The Wells Run would be part of a larger biological waterway connecting a number of aquatic habitats, but the stream bed was replaced with what is now aging concrete, blocking aquatic plants from growing and reducing the number of fish and amphibians that may be found. As the stream system breaks down the concrete and repairs itself, hopefully with the assistance of potential stream restoration projects, that aquatic network may reestablish. The diagram to the lower right shows Maryland's Green Infrastructure as mapped by the Maryland Department of Natural Resources. Riverdale elementary, again a blue circle, is completely enveloped by green, representative of a Green Infrastructure Corridor. Wildlife corridors allow animals, seeds, and pollen travel from one natural area to another, ensuring diversity of habitats and fighting against ecosystem fragmentation. Located with a corridor, Riverdale elementary has the potential to bolster ecological health of Maryland areas far beyond the site boundaries.

Figure 60 Anacostia Watershed Map

Figure 59 MD DNR Green Infrastructure

Chapter 3: Analysis

<u>Opportunities and Constraints</u>

In order to begin applying the theoretical knowledge gained from the above research to a site design, I first evaluated the Riverdale Elementary school property, looking at potential positive features that would be beneficial for aiding design, as well as ensuring I was taking into account all site constraints that may hinder the realization of some of those goals. The site can be broken down into a number of sub-areas that share similar characteristics and can be discussed in part.

Parking Lot- Located alongside the front entrance to the school, Riverdale Elementary's parking lot is an opportunity for redesign. Vehicular circulation can be vastly improved, there is limited available parking that runs short very quickly during pick-up and drop-off hours, leading to consistent situations where parents and faculty are double or triple parked. Riverdale does not have a bus system so this parking lot attempts to handle an uncommonly large amount of parents that drive their children to school. Because of the constant flow of human traffic this space is ideal for demonstrating stormwater techniques and educating the public about water issues in their community, which can be done simultaneously with improving the aesthetic experience of the school's entrance.

School Edges- Property boundaries on site combine with a large building footprint to create uniquely long, linear conditions on either side of the school. The northern edge borders municipal property and street shared by police workers and faculty. The southern edge borders Riverdale Road, a low capacity road that serves local traffic. Because of the proximity of the two streets, these spaces cannot have a large degree of freedom of activity for children as safety is a concern. However, activities that involve stationary learning are still appropriate, and with a certain level of protection, (fencing, screening, etc.) can be converted to outdoor education or seating spaces. Currently neither strip has an excessive amount of programming, the northern strip has a basement entrance and utility cluster that needs to remain accessible but little else. The southern edge is currently used for outdoor seating, but the site furnishings are aging and the connection to the school's overhang/patio area can be improved.

Portable Buildings- Riverdale is currently utilizing four portable classroom buildings as semi-permanent overflow space for their school building. Assuming the classrooms will need to remain, there is an opportunity to rearrange them for a more efficient use of space and a better sense of community. Creating a sidewalk pattern similar to a city grid could achieve this goal and create a 'classroom neighborhood' in contrast to the seemingly haphazard placement that currently exists. Moving the portable classrooms would be an investment to modify utility hookups and structural pads but would open up the rest of the site for redevelopment.

Existing Play Space- Play spaces that exist on the current site represent all of the shortcomings of traditional playground design that have been mentioned earlier in this paper, the focus on physical development, the lack of varied physical activities, and the complete lack of social and cognitive play. The play infrastructure is aging and deteriorating rapidly. The greatest opportunity is the space to create a new, fully realized play experience for the school's children once the old play areas are removed. The location at the rear of the school opens up a number of opportunities to connect any new nature play spaces to outdoor education and to a system of nature exploration that expands all the way out to the Wells Run stream.

MNCPPC Property- Between the edge of the school's property line and Wells Run is a parcel of land owned by MNCPPC. This land is a constraint to the school connecting its nature programming to Wells Run, as MNCPPC has plans to convert this parcel into parking for a new park system that would extend throughout the parcel and into the stream area. Hopefully this design will be able to suggest a way to grant MNCPPC an appropriate amount of parking while still maintaining the connection between school and stream.

Wells Run- A connection to the stream would be an incredible chance to expose children to nature and restorative environmental techniques, as well as helping provide the green corridor mentioned in the Environmental Connections inventory.

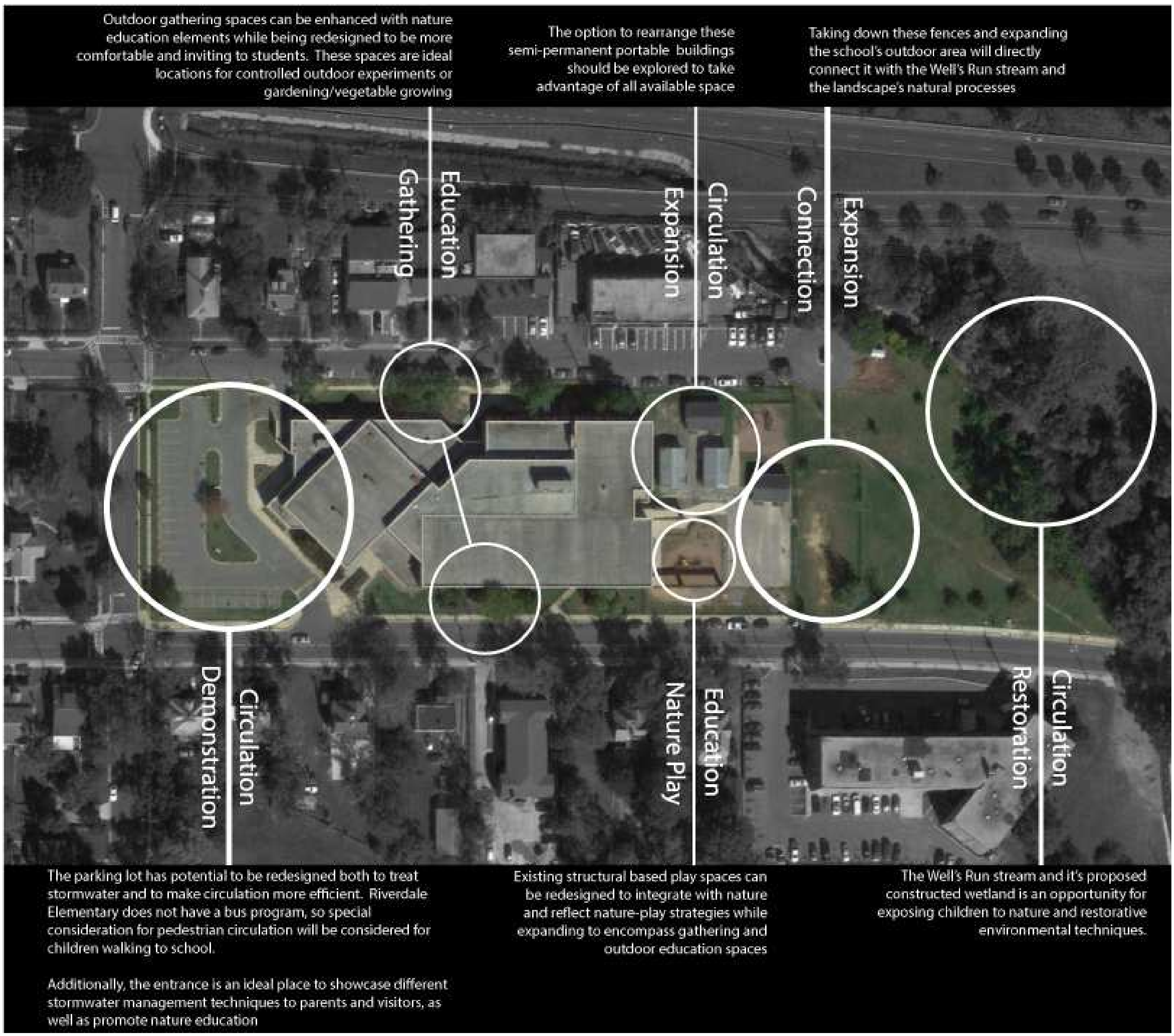


Figure 61 Opportunities and Constraints

Circulation and Parking

Many of the above issues deal with improving circulation on and around the site. The following diagram attempts to visualize these issues, using red to represent vehicular circulation and blue to represent pedestrian/use circulation.

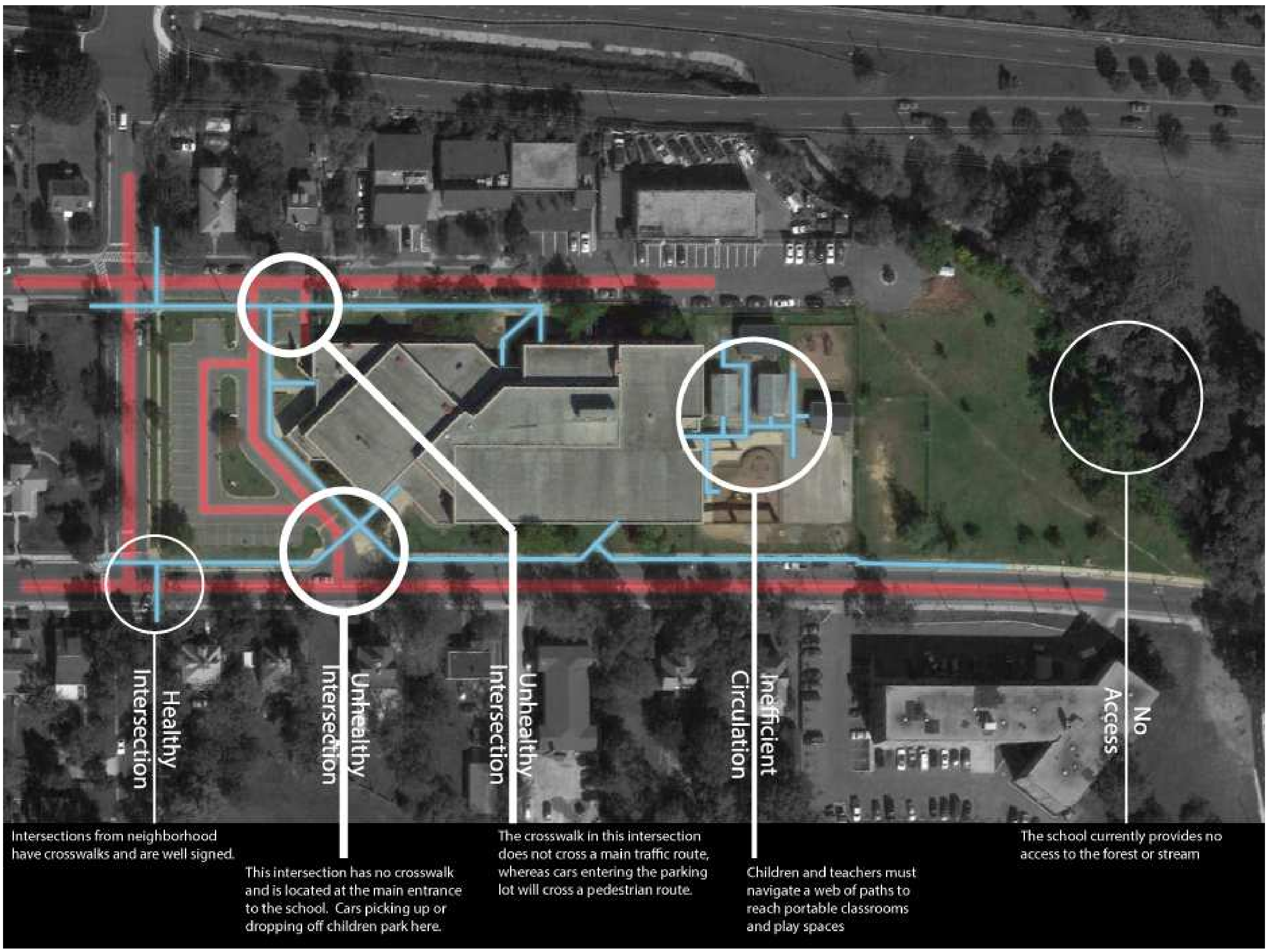


Figure 62 Circulation Analysis

There are a significant amount of spaces where the safety of students and visitors is a concern. Some street intersections are healthy, having crosswalks and large amounts of visibility when crossing the street. Closer to the school however there are pick-up and drop-off zones and delivery zones that cross pedestrian paths close to school entrances, potentially creating unsafe situations.

Programmatic Goals

Before beginning the design process I compiled the data gathered from researching playscapes, nature play, environmental literacy, and childhood development, and attempted to combine that with the site conditions to create a design program. The following list is a condensed breakdown of the goals of this design exercise and what program elements should be included therein.

1. Spaces that foster a full range of physical activities, laid out so children can explore new areas and expand their territorial range as they age.

2. Opportunities for cognitive and social development through malleable environments, encouraged creative expression, and group play.

3. Presence of educational components that promote Environmental Literacy, specifically exposed process education and exposure to a variety of ecosystems.

4. Integration with stormwater management retrofits. This can be done with direct exposure to a stormwater control integrated into the playground itself, or through a strong connection with BMPs present on the site and the planned adjacent constructed wetland.

5. Imaginative or artistic components that create a sense of place and nurture community pride.

This list could be adapted to other school projects and represents a compilation of what an ideal green school exterior should include. There are more specific constraints for this project that need to be addressed, such as improving parking efficiency, or attempting to conform to MNCPPC's plans for the parcel between the school and the stream. The priority of the project is to create a concept for improved outdoor play and education spaces; however good design often is able to solve multiple problems, so synergetic solutions will be sought that combine priority targets with other site improvements.

Functional Diagram

With a set of programmatic goals defined, it is possible to apply those goals to the opportunities and constraints presented by the content of the site inventory and begin to lay out potential design zones within the site boundaries. I first divided the site into four main target zones. While overlap of site functions between the zones is both expected and encouraged, these four zones will concentrate specific goals into the areas where they are most appropriate.

Figure 63 Major Design Zones

The front of the school, due to its visibility and high level of traffic of students, faculty, and visitors alike, is the ideal space for demonstrating stormwater LID controls, as well as promoting the school's message of environmental literacy to the community. The area along the site edges is appropriate for outdoor education in the form of outdoor classrooms and experiments, but not for the freeform nature play that requires additional space and protection from the road, which is possible in the area directly adjacent to the back of the school. Past the site boundary is a natural space for enhancing nature education opportunities. The available space, existing vegetation, and the proximity of the Wells Run stream easily allow nature education without a heavy investment of money or resources.

The four target zones can be further subdivided into a final functional diagram of design spaces. The following diagram outlines these spaces.

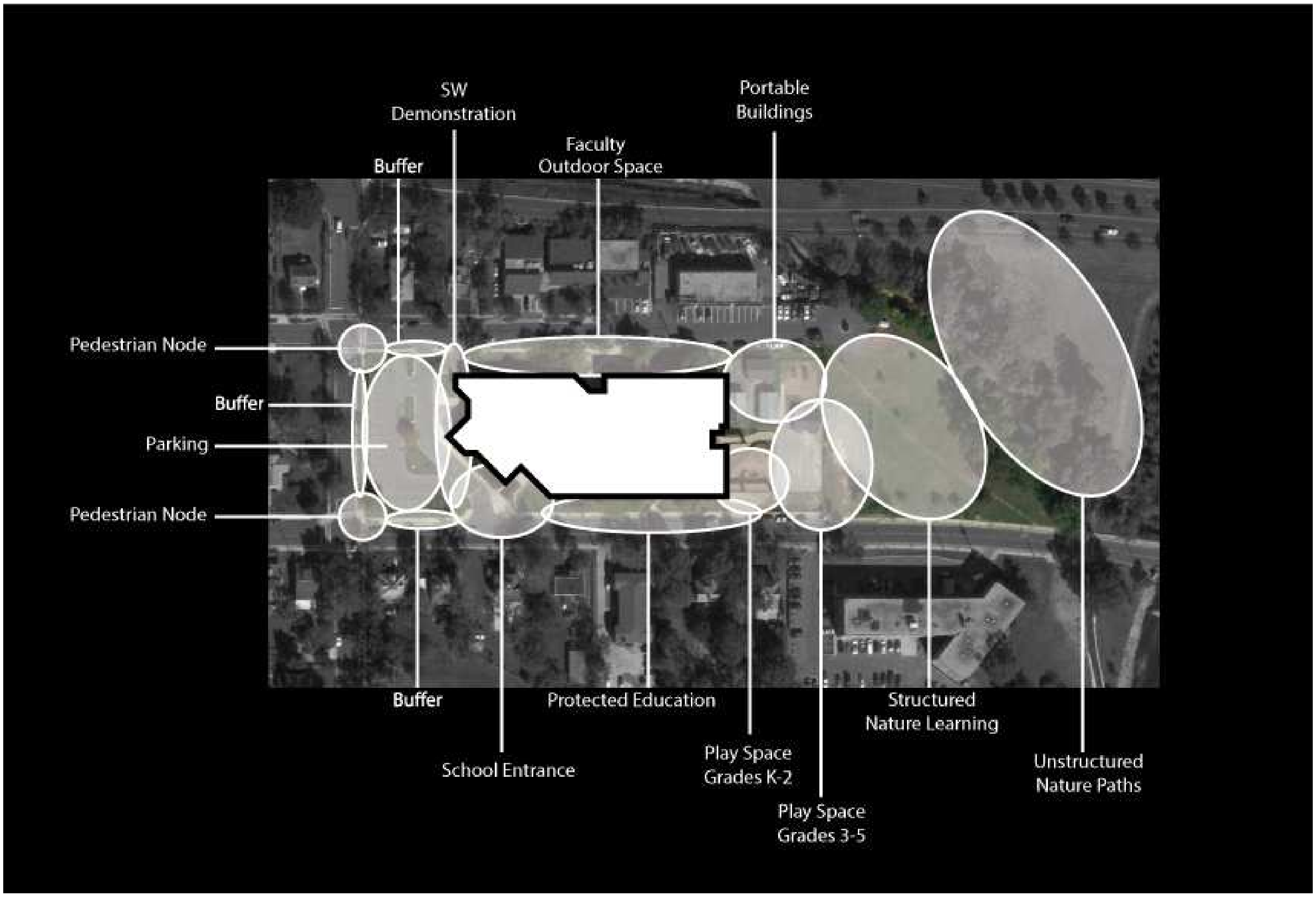


Figure 64 Functional Diagram

The entrance of the school has been broken down to include vehicular and pedestrian circulation patterns within the goal of stormwater demonstration. Pedestrian nodes and vegetative buffers can include stormwater controls and bioretention while still improving parking efficiency and the safety of children walking to and from school. The school entrance is targeted as a specific area to improve visually, with the aim of fostering pride of place around the main membrane between the interior and exterior school. The northern edge of the school will be targeted toward faculty outdoor space. This can be in the form of sitting areas for faculty to eat lunch or have quiet outdoor space for grading papers or other tasks, but also places where the faculty can extend their indoor classrooms outside, with circular outdoor classroom seating space. The portable buildings are a necessity but can be rearranged to allow more space within the nature play area. Beyond the portable classrooms, the rest of the spaces have been arranged to be compatible with childhood territorial expansion.

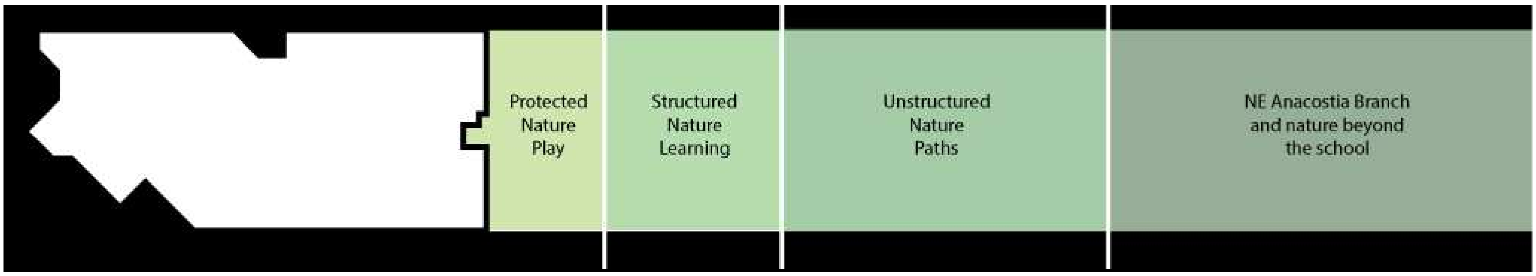


Figure 65 Territorial Range

The back entrance of the school will open out into nature play spaces designed for two age groups, students in in kindergarten to second grade, and students in third to fifth grade. The younger group space will feature exploring malleable materials, building and playing with loose parts, and natural play structures at small scales. The space for older children will be larger and encourage broader ranges of movement as well as music and art spaces. As children age, they will progress from the smaller nature exploration area to the larger playscape. As their range expands, they will be taken to encounter structured nature learning areas; habitat that has been set up to encourage species or to display specific vegetation. There they can encounter nature with the aid of faculty that can explain the functioning of different ecosystem structures. Eventually, the student's territory will expand out to encounter unstructured nature in the form of the wooded area around the Wells Run stream. Nature paths will be created for access, but studying and identifying nature will have to conform to the actual forest and stream as it evolves around the school. This will set up students for eventual progression beyond the boundaries of their school, giving them confidence to approach the larger Anacostia watershed or any unfamiliar nature areas with an attitude of investigation and curiosity.

Faculty Response

It is vital that any design response accurately reflect the needs and desires of the community which it would serve. While throughout this process I have been in contact with Anacostia Watershed Society and Biohabitats, it was important to also obtain user feedback from members of Riverdale Elementary. To that aim I contacted Principal Hughes and arranged a window of time during a staff development meeting where I was able to visit the school and deliver a short presentation. The goal of the presentation was to showcase different precedents of playscape, nature play, and nature education projects, explain how they could fit into a landscape renovation project for Riverdale, and acquire feedback from that faculty. I wanted to hear what ideas they were excited about and how they might connect to their curriculum, but also if any ideas brought up questions of safety, practicality, or any other concerns. They have a level of familiarity with the site that is impossible to obtain through analysis alone, therefore I predicted that beginning a dialogue would illuminate site issues which I had not considered. The full presentation is included as Appendix 1.0.

Response from faculty was extremely positive, the teachers were receptive to the majority of the ideas presented and seemed to agree that nature play focused improvements to the school landscape would be beneficial. The faculty was actually less concerned about safety issues than I anticipated, they had no issues with providing the children climbing or crawling structures created from natural materials and seemed open to the idea of having loose parts available. There were concerns raised about using objects as projectiles, but other faculty mentioned that typical wood chips or anything else on a normal playground could be used as well, and encouraging loose parts may enable a sense of ownership of the space that would make throwing objects less likely. The area where I received the most useful feedback from faculty was that of how the school worked functionally to control 800 students and what that might mean for landscape designs. All of the students line up in the school's entryway, both inside and outside the doors during pickup so keeping that space relatively open for such a large event on a daily basis is crucial. Adding anything to that space could block the flow of students and visitors, so changes in those areas would either need to be minimal or involve an entire redesign of the pick-up zone. The students and faculty also group en-masse during fire drills, and must do this outside and a certain distance from the school building. The only possible space to do this is on the parcel of land owned by MNCPPC, and any potential design would have to factor this space into the layout as well. Besides those concerns the faculty seemed open to change, receptive to the idea of nature play, and very positive all around.

Figure 66 Play Element

Chapter 4: Design

Figure 67 Site Model

Site Plan

The final design for Riverdale Elementary encompasses the entire school grounds and is effectively a complete reworking of the school's landscape. While further diagrams will specify every intervention made, the site plan below shows some major interventions made on the site including parking and the distribution of portable classrooms.

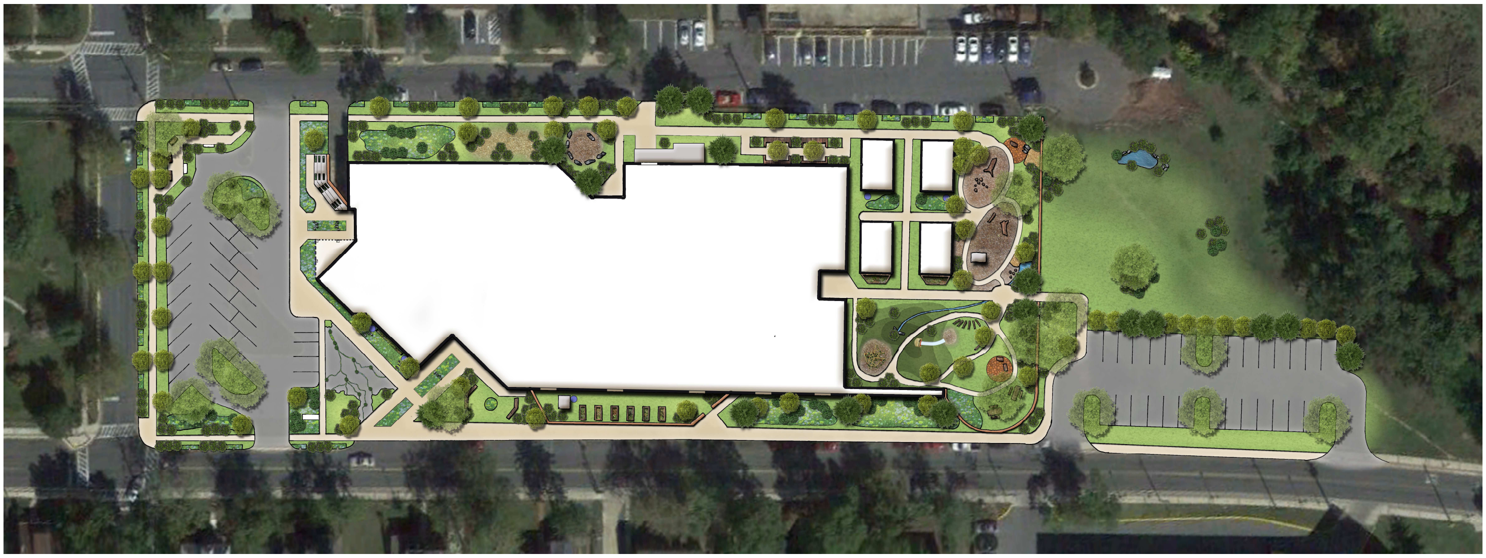


Figure 68 Site Plan

The parking area in the front of the school has been redesigned for efficiency, using angle parking and one way circulation to avoid issues of double parking and to increase the provided number of parking spaces, including proving devoted handicap spaces near the front doors. Safety of the parking area has been improved by pulling the entrance to the parking lot away from the school's entrance and by lengthening the area devoted to pick-up. A secondary parking lot has been added to the rear of the school as a compromise between the aims of the school and the desires of MNCPPC and the Department of Public Works. That parking will become overflow for the school during pick-up and drop-off hours as well as providing parking for the park area to the west of Wells Run. MNCPPC had proposed that parking take up the majority of the parcel in a block stretching north to south. By rotating it so that it falls adjacent to the road the school can maintain a walking connection to Wells Run while retaining space to buffer the parking area from the larger field and the forest. The field allows the school to utilize space for fire drills and other emergency gatherings. Finally, the portable classrooms have been relocated for efficient pedestrian circulation, opening up a large amount of space within the site boundaries that can be converted to school amenities.

School Entrance

Figure 69 School Entrance

Around the area of the school that contains the main entrance the majority of the interventions are designed to demonstrate stormwater management techniques in highly visible locations with the intention of educating and interesting students, faculty, and visitors to the school. Along Taylor Road and Riverdale Road stormwater inlets have been placed that will collect stormwater runoff from those streets to be filtered and stored. These inlets, along with strategically planted trees, serve as a vegetative buffer between pedestrian sidewalks and the road, increasing the safety of students walking to and from school and helping to buffer the school from automotive pollutants.

Two larger traditional rain gardens are placed at either side of the entry to the school's parking lot. I suggest that a new school sign be created and placed in one of these rain gardens solidifying the school's connection to environmental concerns and reflecting a new sense of pride in the school's vision and message.

Figure 70 Dendritic Garden

The existing parking lot has a great deal of asphalt located near the school's entrance, rather than spend the resources on removal and replacement a dendritic garden can be carved out of the asphalt patch. A dendritic garden is low maintenance, allows water to infiltrate, and offers students the unique opportunity to witness how vegetation can break down hardscape over time. Students who attend all five years of their elementary program at Riverdale will be able to record the garden's progress over time. The garden can be shaped like the Anacostia River and a North arrow and river branch labels could be embossed into the concrete, furthering the connection between the school and the watershed.

Along the face of the school entrance is a prominent wall that will be enhanced with the addition of a large living wall. Such a display would connect anyone viewing the school with the green school movement, while also providing a way to use stormwater collected on the roof. Rain barrels will be placed on either side of the living wall and a path or stepping stones created to access those barrels, allowing students the chance to use water harvested from the roof to water the living wall. In a sense the students will be helping to take care of their school's environment by literally watering the school, establishing a sense of personal pride and responsibility for the school's landscape.

The sidewalk around the entrance of the school is large enough to accommodate the flow of all eight hundred of the school's students during a short period of time, but therefore creates large patches of impervious surface. Creating planting beds may create visibility issues, but by removed sections of the sidewalk and installing low height bioretention additional stormwater controls can be created while maintaining a safe entryway.

Alongside the southern edge of the school's entrance will be a small sating area for visitors. Currently there are no spaces for visitors to sit outside, and there are many occasions when for example a parent may be waiting for a child to be released that they may want to do so. This design includes shaded seating areas around a central planting and an art piece. The planting could be a small rain garden or a decorative garden, but the art piece would give the school a sense of permanence and a sense of place in the community. While many different styles would be appropriate, art that tied into the international nature of the school's demographic would be a wonderful unifying addition.

The last feature of this area would be a number of garden plots outside the school. The beds would be protected from the street by a low wall. Each grade level would be given their own bed for planting, experimentation, or however the faculty wants to tie into the curriculum. Students could grow plants that relate to their science classes, that are designed to attract certain species, or that reflect native species of their families' home countries.

Students could measure their heights, draw the plants, collect samples of insects, or even write about their experiences.

Figure 71 School Entrance Perspective

Pick-up, Drop-off, and Gardens

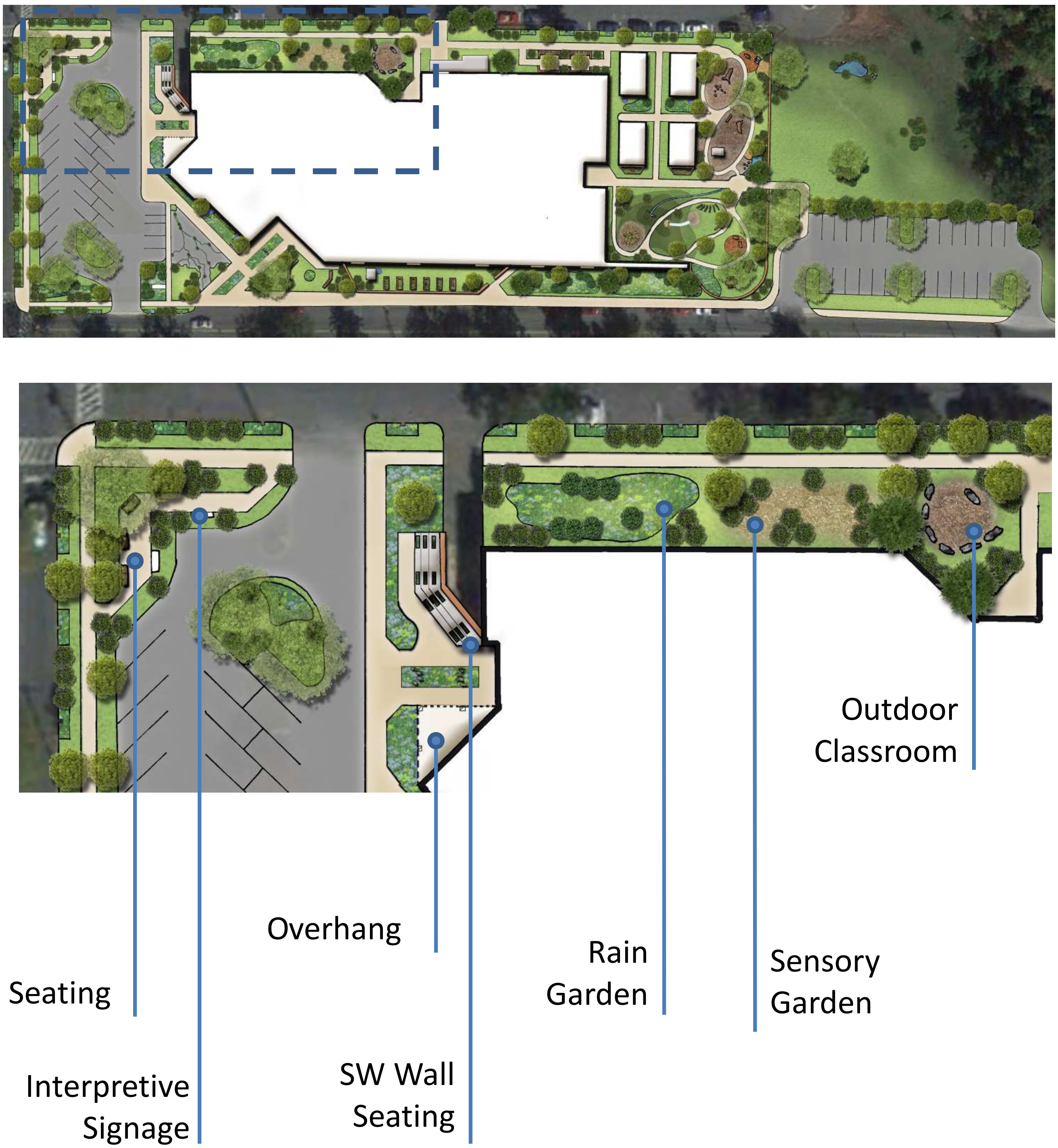


Figure 72 Pick-up, Drop-off, and Garden Callouts

The spaces to the North West of the school contain the main pick-up and drop-off zone and also serve as a demonstration area for stormwater techniques. The secondary entrance has been redesigned to serve as a point of egress for pick-up times by opening up the space and providing spaces for children to wait safely for their rides. An overhang will be built that creates a shelter where children can wait outside during rain events. Encouraging children to wait outside during rain can help draw their attention to natural processes and stormwater flow. Rain chains can be hung from the edge of the overhang providing an auditory and visual connection to the rain as well as a fun and aesthetically pleasing amenity no matter the weather.

Figure 73 Rain Chains

During better weather students will also have somewhere to wait outside. A wall that currently exists on site to screen a utility driveway will be repurposed by adding a system of tiered stairs. Similar to bleachers, these tiers give the students somewhere interesting to sit and wait for a ride. Additionally within the stairs stormwater planters can be built, giving the students another example of stormwater management controls and demonstrating how those controls can be formed directly into the built landscape around them.

The Northwest corner of the site serves as a connection node between the school and the community. Next to the school site is a church that often uses school parking as overflow, and the sidewalk system brings pedestrians walking around the neighborhood through this corner node. It is a perfect location therefore to create spaces activating this connection by providing shade, seating, and plantings that attract visitors through color and scent. The small garden will then focus visitor attention on interpretive signage explaining many of the school's environmental systems, educating the public about stormwater issues and how some of the stormwater controls around the school function. This helps spread the message and goal of protecting the Anacostia watershed into the larger community.

Figure 74 Interpretive Signage

To the north of the school will be a larger rain garden sited where a substantial amount of stormwater can be directed from the streets surrounding the site as well as collected off of the extensive roof system. Adjacent to the rain garden will be a collection of plantings designed to offer a variety of sensory experiences. Students will be exposed to plants with different smells, different colors, and even some carefully chosen plants that they can taste. A sensory garden has great potential to create a connection between the landscape and curricula not traditionally associated with outdoor education such as language arts, visual arts, or music. It also can be used as a therapeutic space where faculty could bring students to help calm them or recharge direct attention.

An outdoor classroom will also be provided on the north side of the school. Faculty at Riverdale requested that a space be provided where classes could be held outdoors. The outdoor classroom is designed to function similarly to an indoor classroom and is laid out more rigidly than other outdoor spaces around the school with seating arranged in a circle around whoever is presenting the lesson to keep attention focused. The space is also heavily screened from the street and other spaces on the side of the school with the dual purpose of providing a significant amount of shade and reducing unwanted distractions.

Figure 75 Drop-off Perspective

Nature Playscape

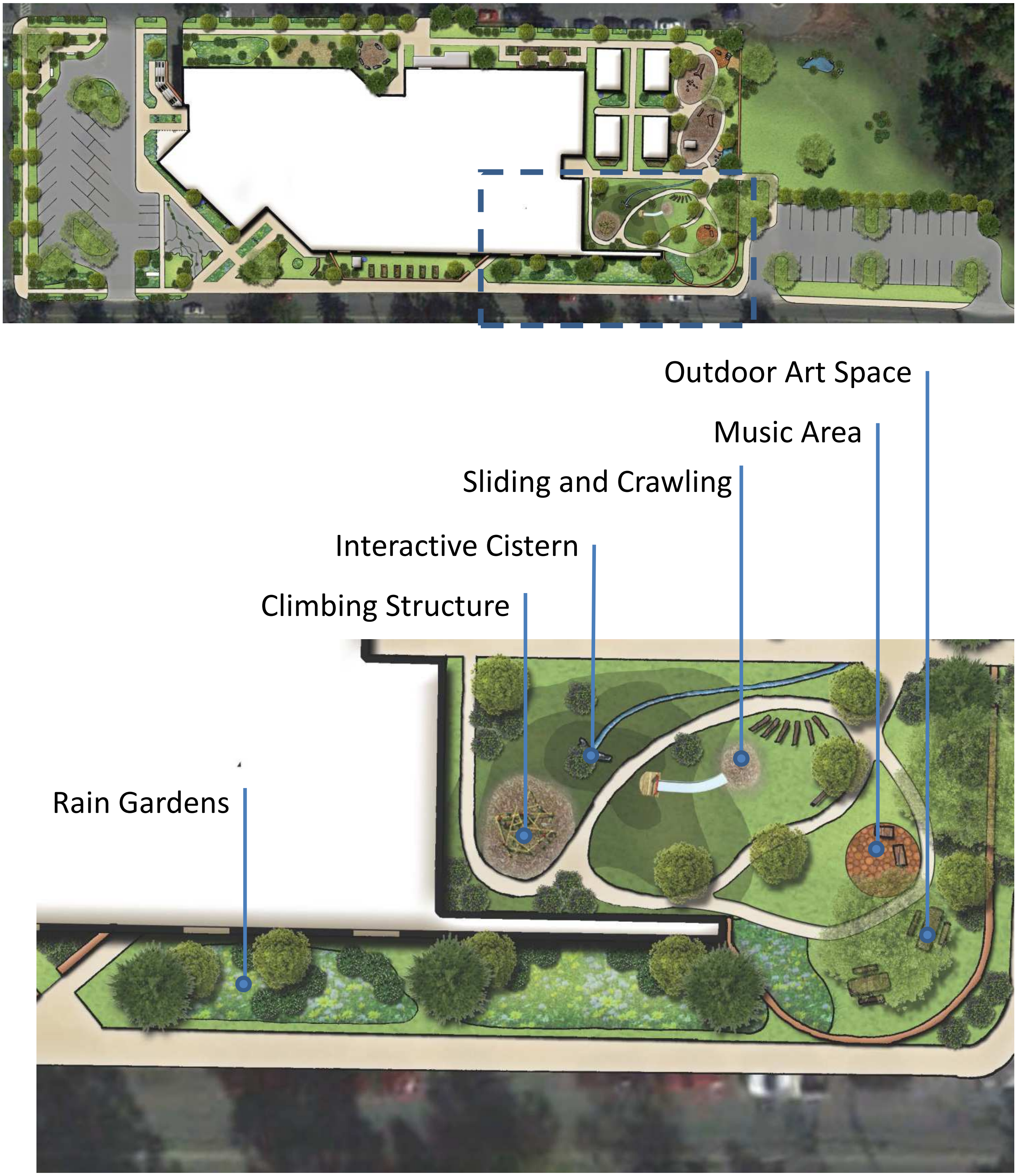


Figure 76 Nature Playscape Callouts

The space to the South East of the school is comprised of a larger bioretention area and the rear of the school building. The bioretention area is formed out of two large rain gardens designed to pass runoff from the street through a treatment train to maximize storage and treatment. A decorative wall extends out from the edge of the school and the rain gardens are designed to frame and accent the cut through window in that wall. It is additionally possible with a gutter and pipe system to turn that cut through wall into a water wall during rain events by having water flow out through a gutter and down into the rain garden which could be visually interesting and attract local attention to stormwater issues.

The rest of the school's exterior in this area is devoted to a large natural playscape. The topography of the area is manipulated to create a landscape on which the students can experience a shift in scale and slope, with the added benefit of covering a large stormwater cistern. This cistern will collect water running off the roof of the school and store it underground. It can be accessed by the students by a small hand pump located at the top of the hill, which will pump water into a channel that runs the length of the playscape. This allows children to have access to water for play and building without being exposed to standing water which is a safety risk. The water channel represents a miniature version of the Anacostia River and provides a sensory connection to the water cycle.

Both outdoor play spaces are divided into a number of stations, each with its own theme. While students may have access to the entire space during play time, a common teaching strategy is to rotate students through stations for a fixed period of time, ensuring the group stays organized and each student has access to as well as motivation to explore each station. The playscape features two of these stations, one of which is devoted to music, and the other to art. The music station provides fixed outdoor music features that remain permanent on a hardscape designed to encourage movement or dance. The art station provides space for a number of students to site and work on arts or crafts projects and proximity to the low wall surrounding the playscape for hanging or pinning art projects. The wall also opens up the possibility for more permanent murals created by the students.

Figure 77 Art Space

The playscape's main features are physical play spaces designed to accommodate older children in grades three through five. The path systems are designed in loops to encourage running and movement, but are placed so they rise and fall vertically within slope limits. The design includes one traditional structure for climbing, with the caveat that the structure is formed in a way that facilitates a variety of physical movements, for example climbing bars of different thickness or textures and surfaces that are varied. The playscape also includes a slide built into the landscape, a crawling structure that can be planted with vines or other vegetation, plenty of space for group games, and balance logs. The playscape will have a large amount of vegetation including both trees and shrubs which must be chosen carefully for safety and interactivity.

Figure 78 Crawling Trellis

Figure 79 Playscape Perspective

Nature Exploration Area and Faculty Seating

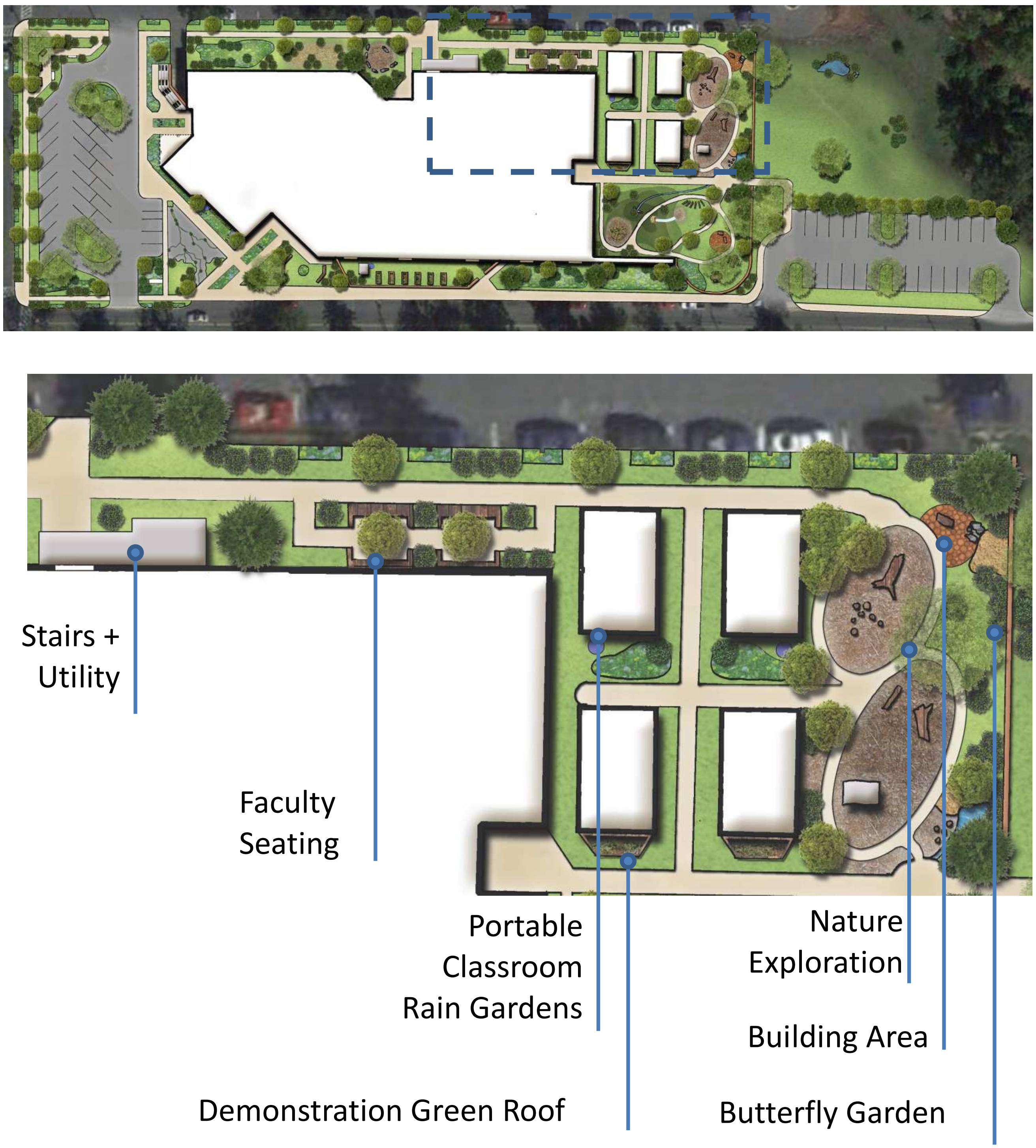


Figure 80 Nature Exploration and Faculty Seating Callouts

The strip of available land to the North of the school includes a space devoted to outdoor utility and basement access, but the area adjacent to that is open for improvement. Faculty at Riverdale mentioned wanting a space outdoors where they could sit, either for lunch or reflection. The design incorporates this goal by providing seating along the north edge of the building with planters for screening and aesthetics as well as ornamental trees for shade.

As stated earlier, the portable classrooms have been rearranged for increased efficiency of circulation and increased use of space. Once placed differently they can be enhanced by providing each portable classroom with a feature that both treats stormwater and can connect to or be taken care of by the class within that building. Two of the portable classrooms have rain gardens and rain barrels, and two have demonstration green roofs. These roofs are placed at child height so that children get a chance to view an environmentally conscious building strategy that is typically hidden from view or inaccessible. Succulents are also easy to play and maintain, so the students would be able to have a direct hand in constructing or maintaining these roofs.

Figure 81 Accessible Green Roof

The play space located here is designed as a nature exploration area. The features within the space are appropriate for the younger children in kindergarten through second grade, though there can certainly be overlap between the years and older students are encouraged to play there as well. The space, like the larger playscape, also has a number of stations set up, both of which deal with loose parts and building. While there will be loose parts available throughout this area the sand and water area lets children explore building with sand and its interaction with water that flows from the cistern in the lower part of the site. The formal building area provides parts such as recycled materials, blocks, small sticks or logs, or whatever faculty wants to arrange. The space has hardscape and tables to encourage pausing from movement and settling in for larger or semi-permanent building projects during a play session.

Figure 82 Building Area

Physical play in the nature exploration area is structured through natural materials. Fallen logs can be brought in as climbing features, hollowed logs make excellent crawling structures, and log slices can be used to make a ‘stump jump.’ There is an advantage to having physical play structures be made out of the same materials as are found around the site or in the building section, children may begin to make the connection between creativity and the objects found around us in the human built landscape.

The edge of the nature exploration area will be planted with shrubs that attract butterflies. As well as being aesthetically pleasing and often having a pleasing scent, a butterfly garden is an excellent way for students to witness ecosystems in action during play sessions. The butterfly garden can be used as an educational tool as well, giving the space a reason to be activated by older children as well as providing a link to science curricula or other classes that expand their lessons to include outdoor education.

Habitats Nodes and their Connection to Wells Run

Figure 83 Habitat Nodes Callout

The final element of the Riverdale design incorporates the parcel of landed owned by the Maryland National Capital Parks and Planning Commission. As stated above, by constructing parking linearly alongside the street a connection can be maintained between Riverdale Elementary and the Wells Run stream. The area to the north of the parking can be used for non-structured nature education. Faculty will be able to take out groups of students to study the outside world as it may appear in nature. While the field is largely kept open to allow for fire drills and other emergencies the design will create habitat nodes that will attract certain species of vegetation, insects, or potentially even larger wildlife.

Figure 43 Nature Education

Students can learn about what species should appear in these habitats and observe how what they expect differs from what they actually record, and in doing so learn about invasive species, successional plantings, and much more. Examples of habitat nodes include insect gardens, a vernal pool, the relationship between nitrogen fixers and nitrogen heavy plants, or a harsh condition garden.

Figure 44 Vernal Pool

Figure 84 Trail Signage

Wells Run and any potential stream restoration project can be accessed at the edge of this space and activated by providing a nature trail. Education stations explaining certain species or restoration techniques can help guide students and community members alike through the space and being to prepare students to seek out and explore nature in the world beyond their school grounds. Understanding the connection between the human environment, in this case Riverdale elementary, with larger natural systems is essential for educating students about environmental issues and, more importantly, proving that these issues matter. Early exposure and positive associations with nature will teach students to want to help fix environmental issues and to live in ways that are sustainable.

Figure 46 Nature Trail

Chapter 5: Results and Discussion

Design Performance

The proposed design for Riverdale Elementary school will conform to the research presented at the beginning of this paper to provide substantially beneficial results for both the student body and faculty of the school. At its core, the design will combat Nature Deficit Disorder simply by providing outdoor green space for the students to experience nature and recharge indirect attention reserves. The design goes much farther than this however by providing specific features that help create opportunities for all facets of developmental learning and satisfy a substantial amount of environmental literacy requirements.

As discussed in the review of current childhood developmental literature, developmental learning in outdoor settings can be broken down into the three main categories of physical, cognitive, and social learning. The design as proposed provides elements that foster all of these categories of development. Physical development is encouraged through the presence of a variety of physical play structures that target a range of motion and affordances including climbing, crawling, sliding, balancing, and jumping. Play areas are divided by approximate age to compensate for a child's natural expansion of their territorial range. Cognitive development is encouraged through a strong connection to environmental learning and education present throughout the play spaces and other outdoor areas. Available loose parts in these areas will help foster creativity and confidence in exploring the environment. Social development will occur in spaces designed for children to work and learn together, in the art and building spaces, the music spaces, and the outdoor classrooms. Being able to build structures out of loose parts and add art to the walls on the playscape will help to create place-making and a feeling of belonging in the school as a whole.

The proposal also satisfies many environmental literacy targets from both the State of Maryland and The North American Association for Environmental Education's national standards. Maryland State's Green Ribbon School program's three 'pillars' of sustainability are all represented in this design. The second and third pillar, Improving Health and Performance and Ensuring Environmental and Sustainability Literacy can both be completed with minimal effort from faculty. Having safely designed enhanced outdoor space for exercise could be combined with a new nutrition program to complete the second pillar. The proposal includes spaces designed to draw attention to and allow students to study sustainability and the relationships between environmental and human systems. Combined with interdisciplinary educational curriculum the design would satisfy the third pillar as well. The first pillar, having a net zero impact, is closer to being completed. However, until the school radically updates its' interior systems and structure that goal will remain out of reach. On a national level, the design provides elements that apply to 6 of the 8 Literacy Standards categories. The only two to which it does not provide direct connections are 3 and 7, Flow of Matter and Energy and Environment and Society. Education related to very micro topics of such as physics and very macro topics such as politics or economics can be loosely linked to outdoor environmental education, but can more discreetly be taught in the classroom.

Stormwater Management

In order to gauge the impact of stormwater management interventions proposed for the Riverdale elementary site I used two methods of estimation. The first method is software released for calculating TR-55, or the United States Department of Agriculture's technical release 55: Urban Hydrology for Small Watersheds. The second method, the EPA stormwater calculator, relies on methods that are more approachable to the general public but may be less accurate. The EPA calculator does display results for annual rainfall quantities which can be helpful. Both estimation methods conclude that the proposed surface changes including reducing impervious surface and increasing the amount of vegetation have significant impact on reducing runoff before stormwater storage is considered.

To run the TR-55 calculations I first determined the surface area of each different surface type present on the existing site. The site has a substantial amount of impervious surface and little vegetation that might slow surface water flow, leading to a large amount of runoff during rain events. Each surface type is given an estimated runoff coefficient describing the proportion of water that will neither evaporate nor infiltrate into the earth in a constant time period. The coefficient is determined by the quality of the soil and the presence of differing vegetation types. The chart on the following page shows the area and corresponding runoff coefficient for each surface type for both the existing site and the proposed site design. These figures assume that any new sidewalk or parking areas will be constructed using pervious materials, and thus represent a best-case scenario relevant to budget concerns.

Surface Type	Area	TR-55 Runoff Coefficient
Existing Conditions		
Impervious Surface	93986 sq ft.	Impervious D (.98)
Structure	47815 sq ft.	
Portable Classrooms	3574 sq ft.	
Sidewalk	26387 sq ft.	
Parking Lot	18891 sq ft.	
Dirt/Mulch	6956 sq ft.	Open Space D <50% Grass (.89)
Grass	74998 sq ft.	Open Space D >75% Grass (.80)
Forest	9719 sq ft.	Woods C Fair (.73)
Total	4.34 Ac.	Weighted CN .89
Proposed Conditions		
Impervious Surface	82898 sq ft.	Impervious D (.98)
Structure	48448 sq ft.	
Portable Classrooms	3574 sq ft.	
Sidewalk	16619 sq ft.	
Parking Lot	14257 sq ft.	
Pervious Groundcover	19920 sq ft.	Gravel C (.89)
Pervious sidewalk	6984 sq ft.	
Pervious Parking	12936 sq ft.	
Dirt/Mulch/Sand	6956 sq ft.	Open Space D <50% Grass (.89)
Grass	74998 sq ft.	Open Space C >75% Grass (.74)
Forest/Habitat	13437 sq ft.	Woods C Fair (.73)
Planted/Grass/Garden	34486 sq ft.	Woods/Grass D Good (.79)
Bioretention	9910 sq ft.	Brush/Weeds/Plants D (.73)
Bioretention Inlets	998 sq ft.	
Stormwater Planters	150 sq ft.	
Rain Gardens	8762 sq ft.	
Total	4.34 Ac.	Weighted CN .87

Table 8 Stormwater Calculations

Tr-55 requires the additional input of a time of concentration, or the estimated time it takes during a rain event for a rain drop to travel from the most hydrologically distant point on the site to the site's outfall. In both existing and proposed conditions that Time of Concentration was determined to be .103 after determining a sheet flow of 96 ft over smooth surface and a remaining shallow concentrated flow for an additional 684 feet over unpaved surface. Average slope over the site is around .02 as the site is very flat. The following chart details the calculated results for multiple storm events.

Storm Severity	Runoff (in)	Storm Severity	Runoff (in)
Existing Conditions		**Proposed Conditions**	
1 Year	1.56	1 Year	1.412
2 Year	2.061	2 Year	1.897
5 Year	2.927	5 Year	2.738
10 Year	3.698	10 Year	3.494

Table 9 Stormwater Runoff

By multiplying the drainage area of the site by the runoff, it is possible to conclude the cubic feet of stormwater flow across the site for each storm event.

Storm Severity	Stormwater Flow	Storm Severity	Stormwater Flow
Existing Conditions		**Proposed Conditions**	
1 Year	24350 cub. ft.	1 Year	22039 cub. ft.
2 Year	32170 cub. ft.	2 Year	29610 cub. ft.
5 Year	45687 cub. ft.	5 Year	42737 cub. ft.
10 Year	57722 cub. ft.	10 Year	54537 cub. ft.

Table 10 Stormwater Total Site Flow

These calculations show that through surface changes alone, the proposed design reduces total stormwater significantly during a 1 year storm, though less so as the storm severity increases. A 1 year storm is reduced by around 10 percent, while a 10 year storm is reduced around 6 percent.

Rainwater storage within the proposed design will contribute the most toward reducing stormwater runoff. The design includes approximately 9,910 square feet of assorted bioretention controls, the majority of which are rain gardens. A convenient estimate would be to assume a ponding height for water storage of 1 foot. That estimate allows bioretention methods onsite to treat and store an additional 45% of runoff total after adjusting for surface changes. The proposed cistern is an element in the design that can handle the majority of leftover runoff from a 1 year storm. The playscape hill will be built over an area that could handle at maximum a 30ft x 30ft cistern at a depth of at maximum 8ft. This would be a potential additional 7,200 cubic feet of storage. A cistern that large would bring total runoff reduction up to 78%.

The EPA stormwater calculator resulted in similar conclusions, with a final estimation of a 76% infiltration rate. More in-depth statistics are listed in the charts of existing and proposed conditions on the following page. I believe that their estimation places infiltration rates for existing conditions higher than is accurate due to the simplified method for entering surface types and therefore determining runoff coefficients, but I believe their adjusted estimate for proposed changes after LID controls is low, due again to a simplified method of entry resulting in having to put controls such as a cistern into one of other, their less accurate categories.

Statistic	Current Scenario	Baseline Scenario
Average Annual Rainfall (inches)	44.44	
Average Annual Runoff (inches)	20.11	
Days per Year With Rainfall	76.85	
Days per Year with Runoff	51.66	
Percent of Wet Days Retained	32.77	
Smallest Rainfall w/ Runoff (inches)	0.10	
Largest Rainfall w/o Runoff (inches)	0.32	
Max. Rainfall Retained (inches)	2.30	

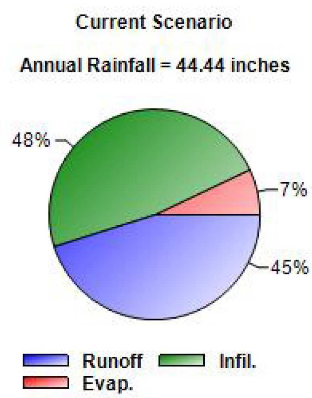


Table 11 EPA Stormwater Calculator Existing Conditions

Statistic	Current Scenario	Baseline Scenario
Average Annual Rainfall (inches)	44.44	
Average Annual Runoff (inches)	9.12	
Days per Year With Rainfall	76.95	
Days per Year with Runoff	32.68	
Percent of Wet Days Retained	57.53	
Smallest Rainfall w/ Runoff (inches)	0.39	
Largest Rainfall w/o Runoff (inches)	0.55	
Max. Rainfall Retained (inches)	3.72	

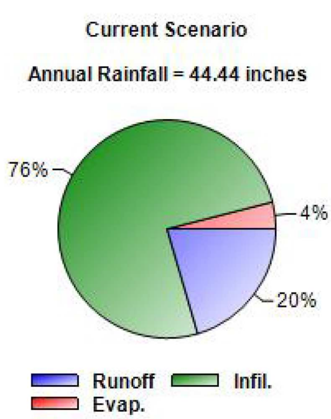


Table 12 EPA Stormwater Calculator Proposed Design

Bioretention, has the capacity to treat runoff as well as allow it to infiltrate. Using calculations taken from the EPA's Urban Runoff BMP Load Reduction Worksheet, the substantial amount of bioretention will have a significant, predictable impact reducing the levels of Carbonaceous-biochemical Oxygen Demand, Total Suspended Solids, Lead, Zinc, Nitrogen, and Phosphorous. Calculations are derived assuming 3 acres of land in the Institutional land-use category and using the Infiltration Trench TMDL reduction algorithm. The following chart outlines these reductions, with Load after BMP adjusted to reflect the bioretention treating 45% of a first flush.

	Load before BMP (lbs/yr)		Load after BMP (lbs/yr)		Load Reduction (lbs/yr)
COD	960		679.2		280.8
TSS	3,960		2,623.5		1,336.5
LEAD	1		0.6		0.5
ZINC	2		1.6		0.5
TN	33		24.9		8.1
TP	4		2.6		1.4

Table 7 TMDL Reduction of Proposed Bioretention

Vegetation

While planting choices are always important for the sustainability and resilience of any landscape project, children's environments involve the additional considerations of health and safety, especially in environments where children are not only allowed but encouraged to interact with the plant life. Plant selection for the Riverdale Elementary school landscape must also consider the proximity of the Wells Run stream. Any planting should attempt to connect to the green corridor along the North East Anacostia branch and so should be comprised of native species that will not compete with the existing ecology. Plant selection should also be hardy enough to resist the effects of street pollution, the encroachment of invasive species, and the constant, often damaging, attention of children.

Plants in children's environments are as much a play objects as they are a play setting. In areas where physical movement is encouraged it will be expected that children will attempt to climb or swing on trees with accessible branches. These trees must be selected so that they are sturdy enough to remain safe as well as having branches low enough that children would not have to attempt any climbing they are not familiar with to access. Branches requiring a boost or help up are dangerous for this reason. Plant selection is important as a play setting also, plants can vary in size, shape, color, and scent to provide varieties of experience for children and varieties of study for students. Varying plant texture, color, and form are all important goals, as well as ensuring the presence of plants with seasonal interest, both as an aesthetic boon but also to help teach children about seasonal change. I have created a list of plants that meet these criteria and would be appropriate to plant at Riverdale Elementary included as Appendix 2.0.

Maintenance

One of the largest changes that this design will bring about is a transition from traditional maintenance strategies to informed maintenance. Traditionally landscape maintenance at public facilities such as schools is simplified as much as possible, resulting in closely cropped lawns making up most of the landscape, with any foreign plant ripped out immediately. The proposed design for Riverdale has a substantial amount of vegetation and bioretention as well as specific habitat groupings, all of which will need specific maintenance strategies to keep healthy. Targeted landscape maintenance can be divided up between a group of volunteers or faculty that is willing to learn about the various plant types in their section and be responsible for its upkeep. Programs that exist beyond the barrier of the school year are good ways to obtain a sense of community engagement in the school's future, as well as to encourage graduates of the school system to stay in the area. They rely on a large amount of that engagement however, so during installation and a period of community adjustment, a small number of individuals may need to complete a large amount of work. An advantage of a school environment is the existence of students as a massive workforce. While they may not be expected to learn complete maintenance strategies, they can help weed and water and will learn while doing it. By taking care of their school they will learn to take pride in their community and by extension with themselves.

It is important to ensure children are allowed and encouraged to interact with the vegetation. The success of loose parts play relies on the freedom to find, manipulate, and even destroy sticks, bark, and other natural materials found in the play space. While faculty may find a balance wherein they discourage children from harming living plants, for example not allowing them to break any living branches off a tree, the discarded natural material must remain available. That means a shift in perception of what defines a 'clean' space is necessary. If sticks are picked up, leaves are raked, and pine cones trashed, the once natural play space begins to transform into the type of playground these designs are meant to avoid. It is important to allow children freedom to explore vegetation on their own terms as well. Large shrubs for example offer a large variety of special qualities that children may love to explore, teaching them about scale and offering the possibility for subtle or complex social interactions (Moore, 93). Plant-enclosed space make excellent hide-outs and refuges, and in some cases also help soften the transition between indoors and outdoors for children who have difficulty adjusting, especially important for children who spend little to no time outdoors already, or for example for children who have difficulty adjusting to sudden changes in light levels (Kirkby, 89). Therefore if a child wishes to crawl inside a shrub to make a fort it should not be an incident of contention as it is a natural reaction to having a rich play environment. If play such as this is encouraged however the rewards are immense. Between the developmental advantages created by exposing children to nature on a regular basis, and the feeling of connection and pride that will develop between the children and their school, the students at Riverdale elementary will become environmentally conscious citizens with a drive to live responsibly and to love and cherish their home.

Conclusion

Allowing children the opportunity to have increased exposure to nature and environmental education is extremely important for both the individual children and for society. The potential for access to nature alleviating symptoms of mental health or attention problems can have lasting effect on a child's development and education. Nature play and education directly affect childhood development as well, helping them grow mentally and physically and helping them learn to socialize and become confident and creative. On a societal level, access to nature helps children build environmental literacy, teaching them natural processes and how environmental concerns shape the world in which we live. Until providing nature access is a priority a strong strategy for accomplishing design projects is to find synergistic goals. Nature play spaces and educational elements can be created as part of projects that satisfy other environmental concerns. While in the case of this project those concerns were stormwater management, there are other possibilities including habitat restoration, erosion control, public open space, and even residential design. The best case scenario however would be national attention being given to issues of nature access. Policy changes could enhance our current legislation requiring outdoor space for children in schools to include access to green space and nature play. Regardless of policy, the more spaces designed and created for children to spend time in nature the better. I sincerely hope the growing trend of researching, calling for, designing, and creating nature play continues.

Appendices

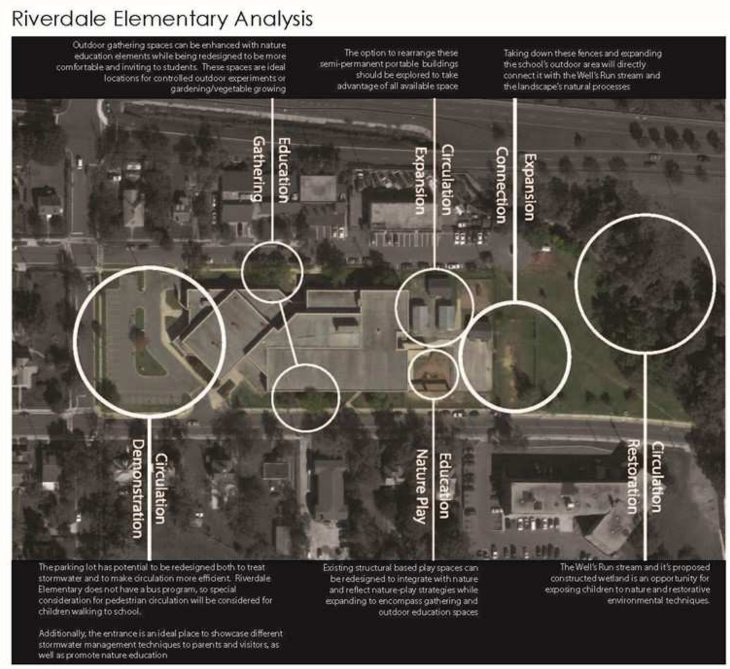
1.0 Presentation to Riverdale Elementary Faculty 12/15/14

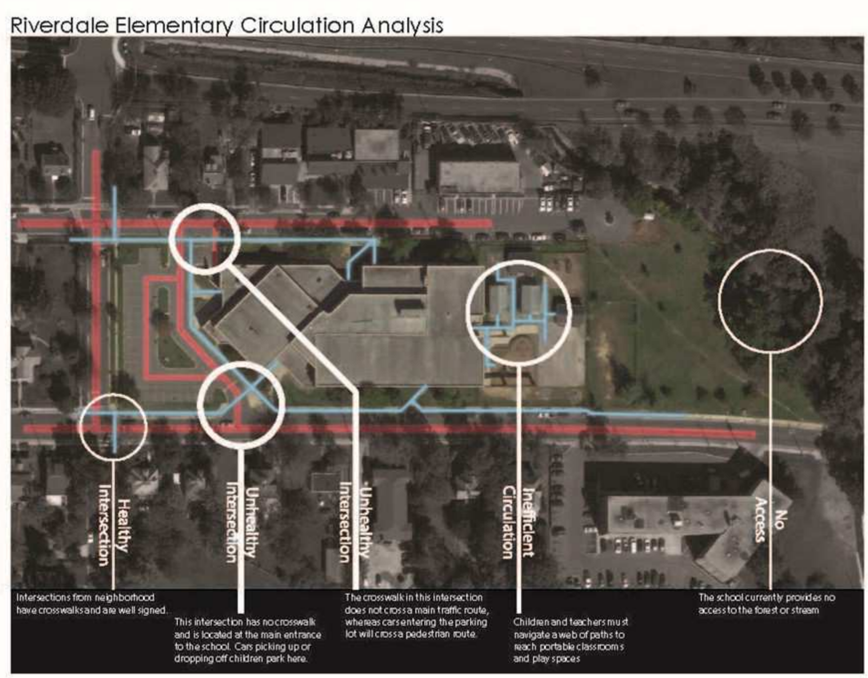
Slides 1 - 14

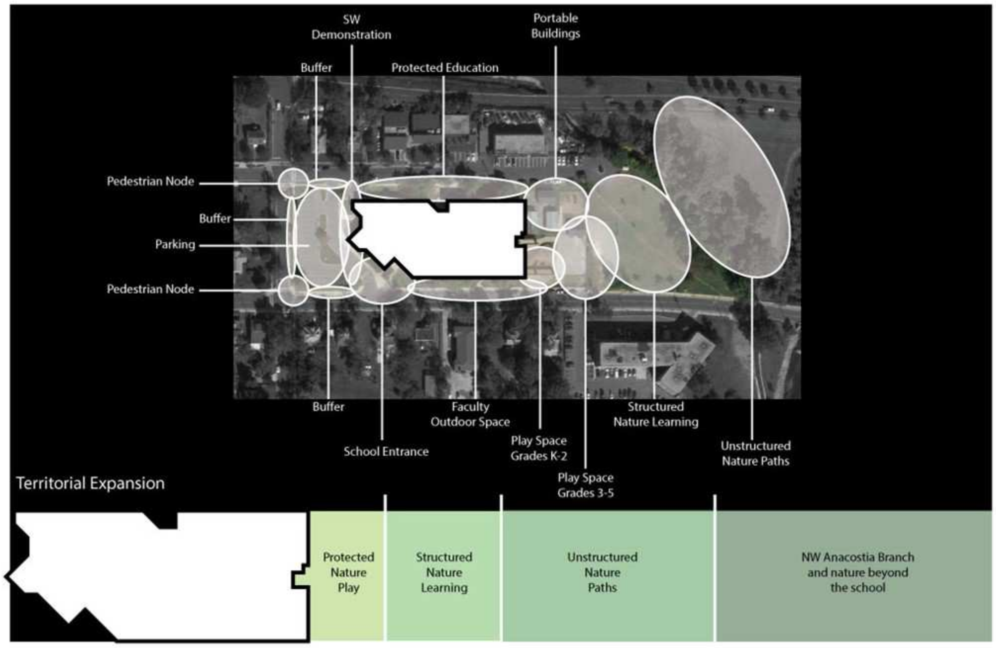
Riverdale Elementary

Nature Education
Design Concepts

Jonathan Gemmell
University of Maryland


Riverdale Elementary Analysis
Outdoor gathering spaces can be enhanced with nature education elements while being redesigned to be more comfortable and inviting to students. These spaces are ideal locations for controlled outdoor experiments or gardening/vegetable growing
The option to rearrange these semi-permanent portable buildings should be explored to take advantage of all available space
Taking down these fences and expanding the school's outdoor area will directly connect it with the Well's Run stream and the landscape's natural processes
Education Gathering
Circulation Expansion
Expansion Connection
Circulation Demonstration
Education Nature Play
Circulation Restoration
The parking lot has potential to be redesigned both to treat stormwater and to make circulation more efficient. Riverdale Elementary does not have a bus program, so special consideration for pedestrian circulation will be considered for children walking to school.
Additionally, the entrance is an ideal place to showcase different stormwater management techniques to parents and visitors, as well as promote nature education
Existing structural based play spaces can be redesigned to integrate with nature and reflect nature-play strategies while expanding to encompass gathering and outdoor education spaces
The Well's Run stream and it's proposed constructed wetland is an opportunity for exposing children to nature and restorative environmental techniques.


Riverdale Elementary Circulation Analysis
Healthy Intersection
Unhealthy Intersection
Unhealthy Intersection
Inefficient Circulation
No Access
Intersections from neighborhood have crosswalks and are well signed.
This intersection has no crosswalk and is located at the main entrance to the school. Cars picking up or dropping off children park here.
The crosswalk in this intersection does not cross a main traffic route, whereas cars entering the parking lot will cross a pedestrian route.
Children and teachers must navigate a web of paths to reach portable classrooms and play spaces
The school currently provides no access to the forest or stream

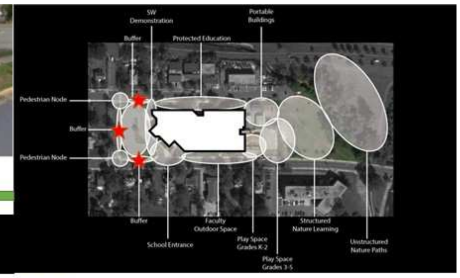


SW Demonstration
Portable Buildings
Buffer
Protected Education
Pedestrian Node
Buffer
Parking
Pedestrian Node
Buffer
Faculty Outdoor Space
Structured Nature Learning
School Entrance
Play Space Grades K-2
Unstructured Nature Paths
Play Space Grades 3-5
Territorial Expansion
Protected Nature Play
Structured Nature Learning
Unstructured Nature Paths
NW Anacostia Branch and nature beyond the school

Pedestrian Nodes
Riverdale Elementary Nature Education Design

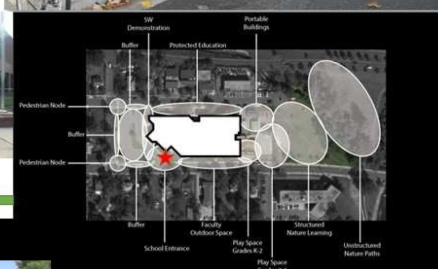
Vegetative Buffers

Riverdale Elementary Nature Education Design

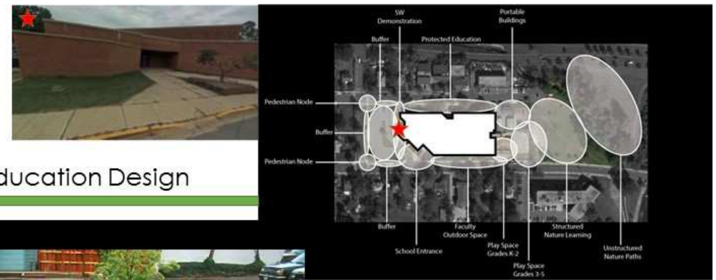


School Entrance

Riverdale Elementary Nature Education Design

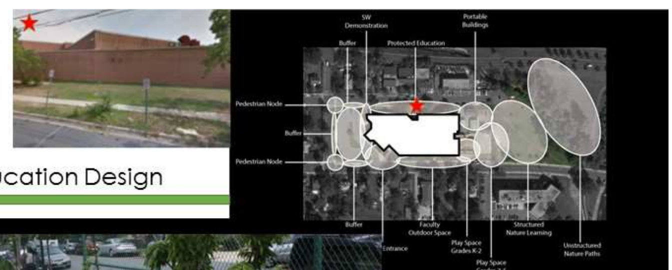


Stormwater Demonstration



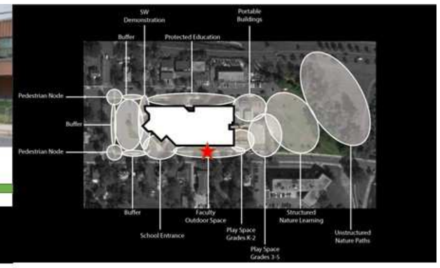
Riverdale Elementary Nature Education Design

Protected Education

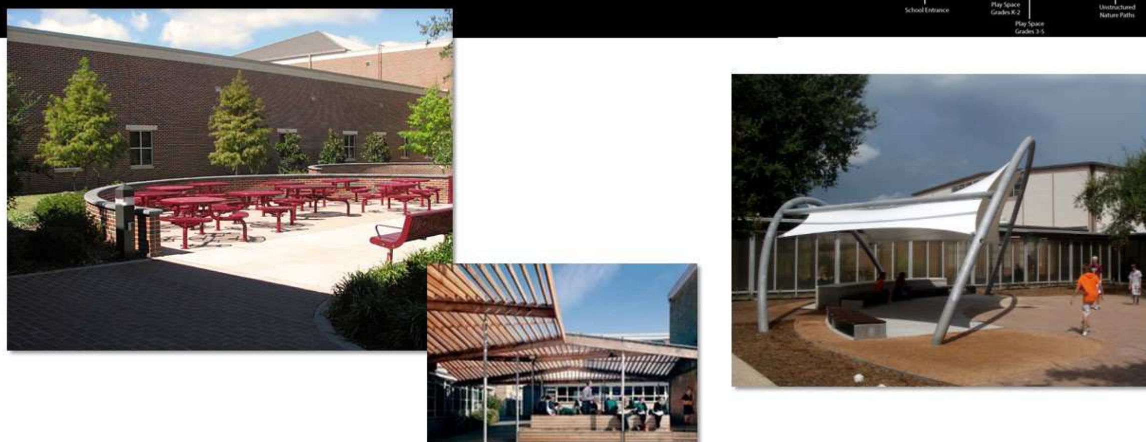


Riverdale Elementary Nature Education Design

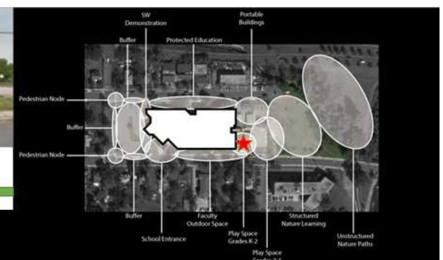
Faculty Outdoor Space



Riverdale Elementary Nature Education Design

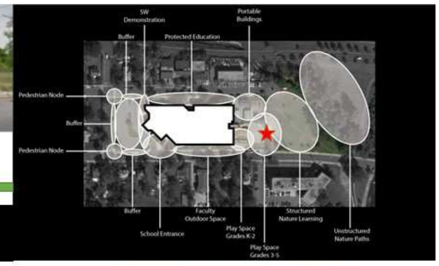


Grades K – 2 Play Space



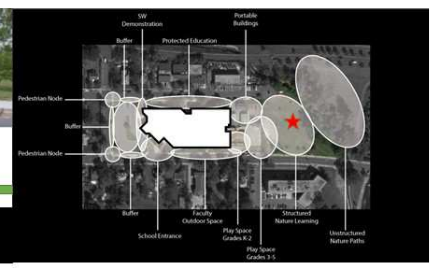
Riverdale Elementary Nature Education Design

Grades 3 – 5 Play Space



Riverdale Elementary Nature Education Design

Structured Nature Learning



Riverdale Elementary Nature Education Design

2.0 List of Suggested Vegetation

Shade Trees

Red Maple *Acer rubrum* seasonal interest, samaras, climbing and swinging

American Beech *Fagus grandifolia* climbing and swinging

Southern Magnolia *Magnolia grandiflora* fragrance, hiding places, winter berries

Common Hackberry, *Celtis occidentalis* climbing and swinging, fruits

Sweet Gum, *Liquidambar styraciflua* seasonal interest, pods

River birch *Betula nigra* wildlife value, winter interest (bark)

Evergreen

Eastern Red Cedar *Juniperus virginiana* fragrance, winter berries, wildlife value

Eastern White Pine *Pinus strobus* fragrance, winter berries, wildlife value

Ornamental Trees

Sweetbay Magnolia *Magnolia virginiana* fragrance, winter berries

Eastern Redbud *Cercis Canadensis* seasonal interest, seasonal pods

Fringetree, *Chionanthus virginicus* fragrance, hiding places

Thornless Honey Locust *Gleditsia triacanthos* var. *inermis* seasonal interest

Flowering Dogwood *Cornus florida* seasonal interest, wildlife value

Witch Hazel *Hamamelis virginiana* winter flowers

Shrubs

Bayberry *Myrica pensylvanica* fragrance, winter berries/interest

Butterfly Bush* *Buddleia davidii* fragrance, seasonal interest, wildlife value

Spicebush *Lindera benzoin* fragrance, wildlife value

Fragrant Sumac *Rhus aromatica* fragrance, wildlife value

Dwarf Fothergilla *Fothergilla gardenii* fragrance, seasonal interest, winter flowers

Large Fothergilla *Fothergilla major* fragrance, seasonal interest

Vines

Trumpet Vine *Campsis radicans* fragrance, wildlife value, seasonal interest

Coral Honeysuckle *Lonicera sempervierens* wildlife value, seasonal interest

*The butterfly bush is non-native and occasionally invasive, but worth including due to its high wildlife attraction and attractive color. There are available cultivars that are less invasive.

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