# Are blue green solutions the future of school grounds?

A case study of blue green solutions providing play and learning opportunities at Strandängsskolans school ground

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# SAMMANFATTNING

Förtätning och klimatförändringar innebär ett högt tryck på urbana miljöer, som i allt högre utsträckning behöver innefatta flera funktioner på begränsad yta. Skolområden, värdefulla stadsrum, måste byggas om till att bli multifunktionella. Syftet med denna uppsats är att förstå hur skolområden kan etablera blågröna lösningar (BGS) som inte bara främjar ekosystemtjänster men även lek och lärande. Med en skola i Båstads kommun som exempel, genom litteraturstudier, dokumentanalys, intervjuer och observationsstudier besvaras studiens forskningsfråga: Hur kan dagvattenhantering ge möjligheter till lek och lärande? Samt delfrågan: Hur kan dagvattenhantering tillämpas i ett förslag till Strandängsskolan som ger möjligheter till lek och lärande? Resultaten från studien har formulerats om för att informera om 10 design principer som omfattar hur lek och lärandemöjligheter kan främjas genom att integrera BGS på skolområden. Designprinciperna sammanfattas i de tre pelarna: multifunktionell, tillgänglig och naturalistisk, vilket också är konceptet för designförslaget. Slutsatsen är att förslaget bidrar till dagvattenhantering som ger möjligheter till lek och lärande och ekosystemtjänster med andvänding av designprinciperna. Generellt sett kan fler skolområden dra nytta av att integrera BGS. Integrering av BGS på skolområden är åt andra sidan bara ett sätt att bemöta de urbana utmaningarna kring hälsosam utveckling av barn samt klimatförändringar.

# ABSTRACT

Densification and climate change mean high pressure on urban environments, which increasingly need to include several functions in a limited area. School areas, valuable urban spaces, must be rebuilt to become multifunctional. The purpose of this thesis is to understand how school grounds can establish blue green solutions (BGS) that promote ecosystem services as well as play and learning opportunities. With a school in Båstad municipality as an example, through literature studies, document analysis, interviews and observational studies, the study's research question is answered: How can stormwater management provide opportunities for play and learning? And the sub question: How can stormwater management be applied in a proposal for Strandängsskolan that provides opportunities for play and learning? The results of the study have been used to form the 10 design principles that encompass how to promote play and learning opportunities from integrating BGS on school grounds. The design principles are summarized by the three pillars: multifunctional, accessible, and naturalistic which is also the concept for the design proposal. The conclusion is that the proposal successfully integrates BGS by providing play and learning opportunities and ecosystem services with the use of the design principles. Generally, more school grounds can benefit from integrating BGS. Integration of BGS on school grounds is however only one way to respond to the urban challenges of the healthy development of children and climate change.

# PREFACE

My interest in this research topic originated during my bachelor's studies at The University of Sheffield. The university department's lecturers and professors were involved in local stormwater management projects such as the *Grey to Green Scheme* in Sheffield and provided me with an interest in the sub-field. In this study I wanted to combine this interest together with another of my interests, school grounds. I grew up in Helsingborg, Sweden and attended an outdoor preschool where we explored the outdoors in one way or another every day. This experience has made me gain a positive attitude and love for nature. In 2020, I was commissioned by my previous school in the Netherlands, The American School of the Hague to re-imagine a courtyard on the campus. Working together with teachers, a gardener, and the special education program, I helped them develop a proposal that aimed to provide a green oasis with play and learning opportunities. Together, these experiences have led me to want to explore the possibilities of play and learning as part of integrating blue green solutions on school grounds.

I would like to begin by thanking my supervisor Julia Schneider as well as Scott Wahl for your guidance and patience throughout the process. I would also like to thank the staff at Strandängsskolan for your encouragement of the project as well as Båstad municipality and all those who took their time to do an interview. I would finally like to thank my family, friends and classmates for the inspiration and support during this time.

Alnarp, 16/09/2022

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# 1.0 KEY WORD DEFINITIONS

**The definitions below explain the central concepts of the study.**

**Stormwater management:**
Detaining and treating rainwater or melted snow locally onto for example streets and lawns instead of risking flooding due to impervious surfaces. Pavement and roofs prevent precipitation from naturally soaking into the ground whilst managed stormwater is absorbed into the soil and infiltrates and replenishes aquifers or flows into streams and rivers (EEC 2022; EPA 2022).

**Blue green solutions:**
Blue green solutions (BGS) are aboveground, ecological stormwater facilities. BGS can be seen as a collective term for sustainable multifunctional measures that contribute to positive synergy effects including the ecosystem services: infiltration, cleaning and delaying stormwater, climate control, biodiversity, air quality and recreation (Bozovic et al. 2017; Boverket 2010; Mottaghi et al. 2021).

**Ecosystem services:**
A collective term for the functions and services that nature can provide (Göteborg Stad 2014).

**Biotope:**
A unique natural ecosystem constituted by a variety of organisms in a biological community and existing in a certain region (Huang et al. 2017).

**Integrated spatial design:**
A non-hierarchical landscape in which affordances complement each other rather than compete (Mottaghi et al. 2021).

**Affordance:**
The possibilities for action that an environment offers to animals, including humans (Gibson 2014). For example, an elevator button affords being pressed on.

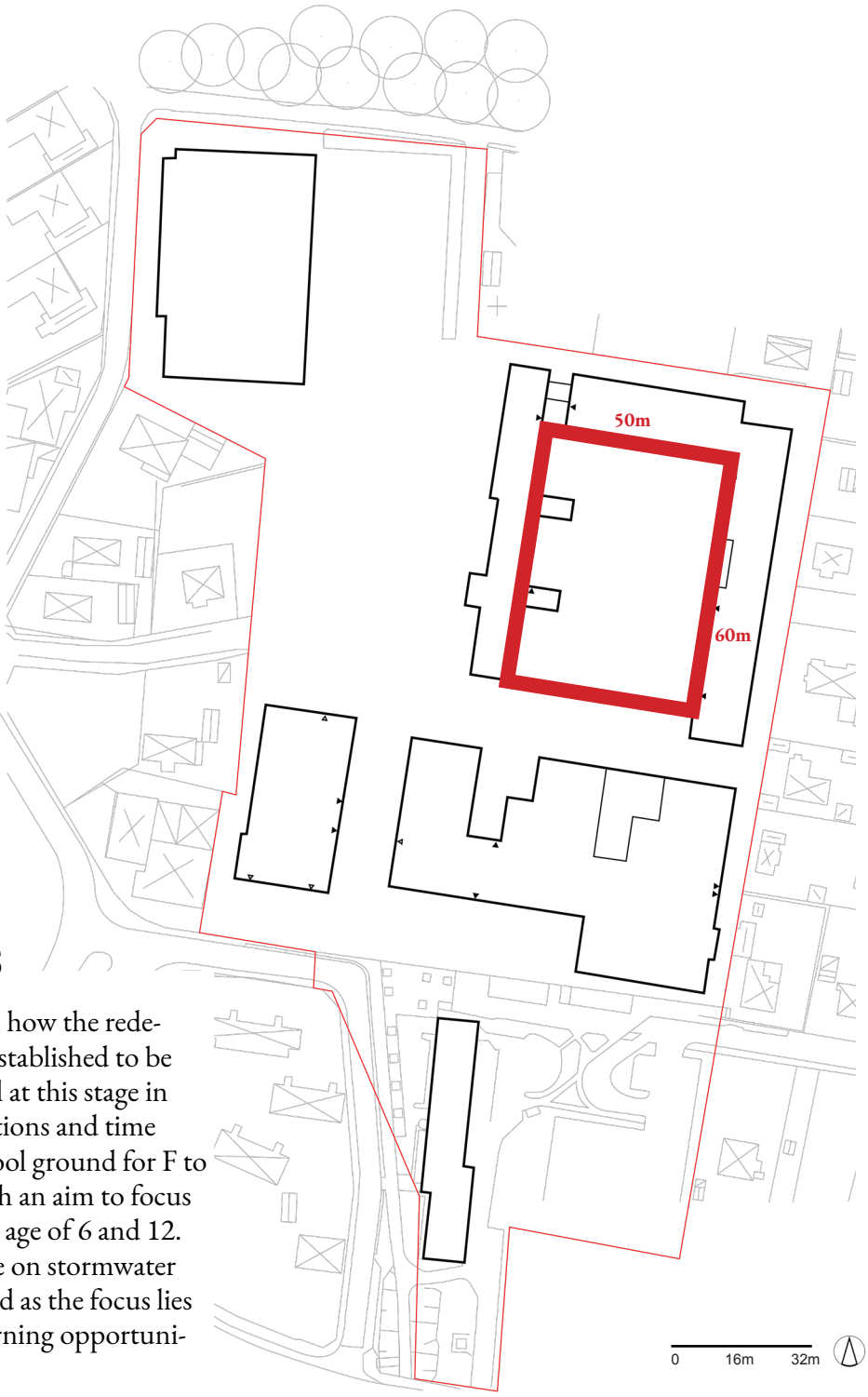
**Actualized affordance:**
Acting on the realization of potential affordances (Heft 1989). For example, actualized affordance occurs when an elevator button is pressed on.

# 2.0 INTRODUCTION

The trend of urbanisation continues to "grow inwards" in Sweden and Europe (Kristensson 2003; Björklid & Gummesson 2013), consequences of increased densification such as less space for children, are becoming apparent (Björklid et al. 2012). Spaces designated for play are diminishing as school grounds are being built upon (Kylin & Bodelius 2015). In combination with the depletion of urban green space, green school grounds take on a greater role in the healthy development of children (Mårtensson 2013). Every day, almost two million children and teenagers go to preschools and schools in Sweden. Preschools and schools outdoor environment are thus a central part of the daily life for most children in Sweden (Boverket & Movium 2015). Green school grounds also play an important role in the bigger picture: to create conditions for good health on equal terms for the entire population, as well as establish a good-built environment (Regeringen 2002).

A denser urban fabric has created secondary challenges connected to climate change. Increased extreme weather events, sea-level rise, as well as heat waves and drought (UN Office for Disaster Risk Reduction 2019; Båstad Municipality & NSVA 2015), are testing the multi-functionality of urban landscapes. School grounds is a prime example of an urban landscape that can contribute to other values.

Blue green solutions (BGS) can be seen as a collective term for sustainable multifunctional measures that contribute to positive synergy effects including the ecosystem services: infiltration, cleaning and delaying stormwater, climate control, biodiversity, air quality and recreation (Bozovic et al. 2017; Boverket 2010). What is evident is that BGS can perform several functions in a landscape. This includes integration in (urban) school grounds. To be able to successfully integrate BGS, research needs to be carried out to further bridge the knowledge gap of BGS and play and learning opportunities. This study, therefore, explores how BGS can promote play and learning opportunities on school grounds. The main research question is: How can stormwater management provide opportunities for play and learning? And the sub question: How can stormwater management be applied in a proposal for Strandängsskolan that provides opportunities for play and learning?




## 2.1 DELIMITATIONS

I will make some assumptions on how the redevelopment of the school will be established to be able to produce a design proposal at this stage in time. As a result of these assumptions and time restraints, I will focus on the school ground for F to F-6 and its surrounding areas with an aim to focus on younger children between the age of 6 and 12. Extensive background knowledge on stormwater management has not been covered as the focus lies on its interplay with play and learning opportunities.

Figure 3: *Location plan of the F-F6 school ground at Strandängsskolan* (Adapted from Ortofoto © Swedish Land Survey).

## 2.2 STRANDÄNGSSKOLAN

Strandängsskolan is a F-9 school located in Båstad municipality. Integration of BGS at Strandängsskolan is strengthened by Båstad municipalities own regulations stating that: **"stormwater and drainage water from buildings on new or remodelled municipal, state, communal or private land needs to be taken care of appropriately to infiltrate, clean, delay, and carry away storm water as well as be multifunctional"** (Båstad municipality & NSVA 2015, pg 5). The school, Strandängsskolan, is being redeveloped and therefore needs to respond to the regulations from Båstad municipality. Remodelling of a building combined with the downward sloping topography of central Båstad provides a basis for BGS to form an important function in this landscape. Integrating BGS can help clean and delay contaminated stormwater before it travels into Båstad sea promenade and Laholms bay area. The school is located between Båstad's sea promenade and its central parts including the city's sports area, and main square, Lyckantorget. According to Båstad municipality the disconnect between these areas can be improved through the encouragement of outdoor play and learning in addition to already established indoor learning.

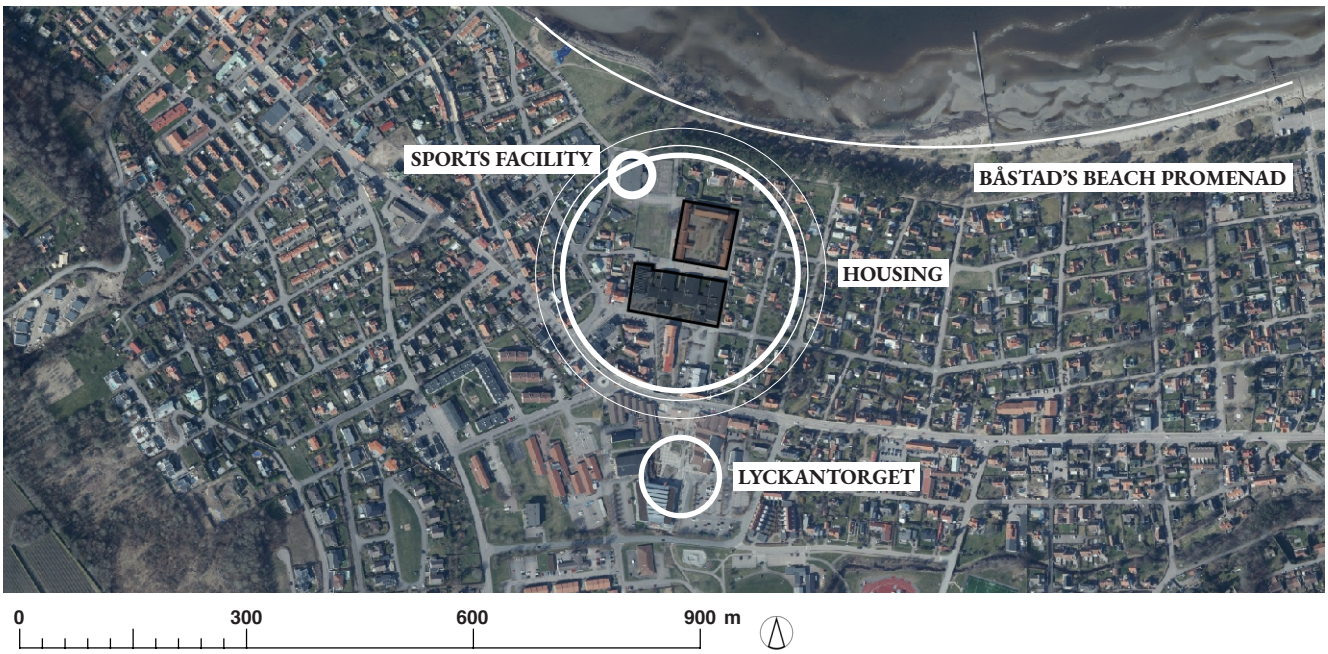
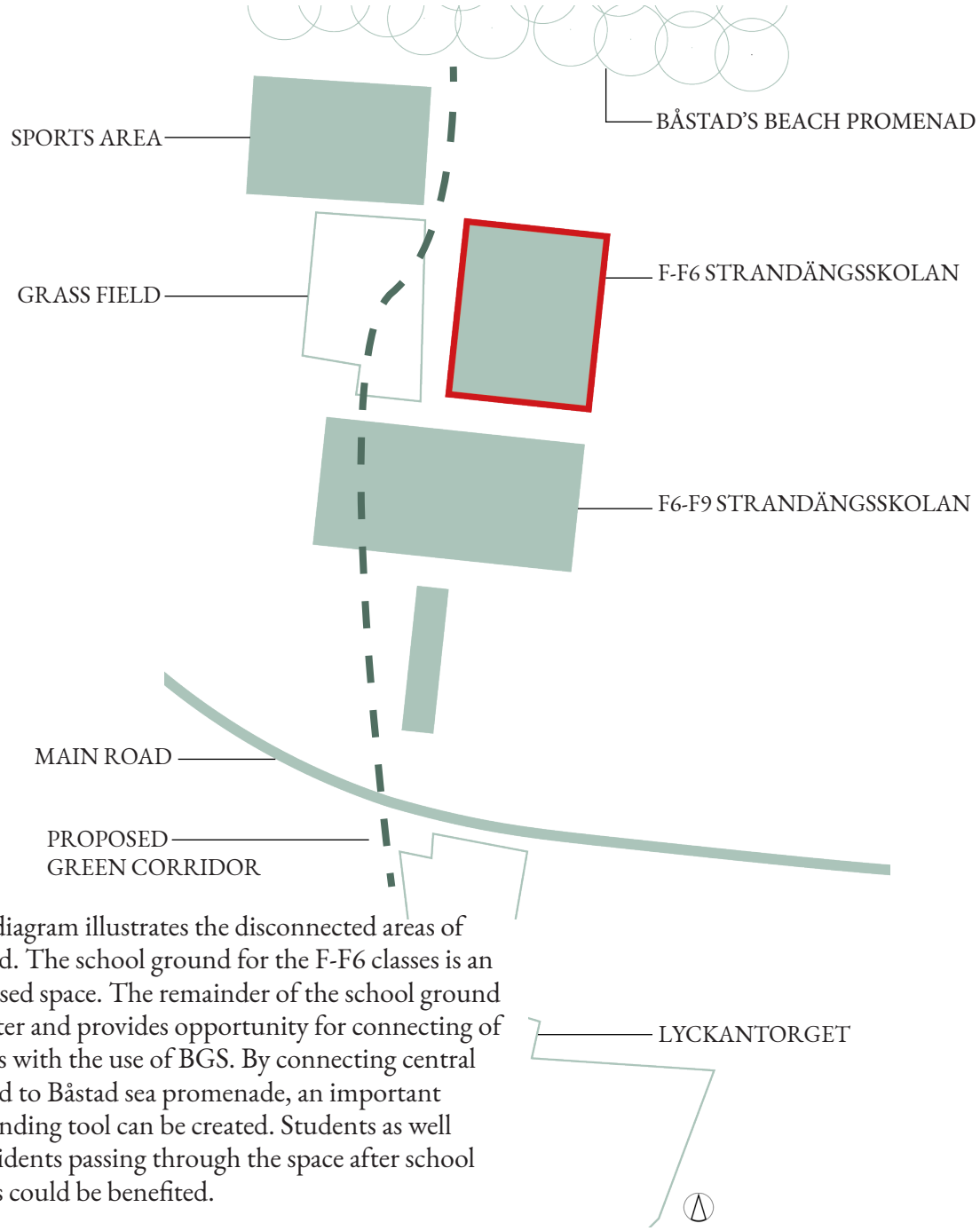



Figure 1: *Ariel photograph of Båstad, with Strandängsskolans buildings* (Ortofoto © Swedish Land Survey).


Image 1: *Ariel photograph depicting the study site at Strandängsskolan* (Ortofoto © Swedish Land Survey).




The diagram illustrates the disconnected areas of Båstad. The school ground for the F-F6 classes is an enclosed space. The remainder of the school ground is vaster and provides opportunity for connecting of spaces with the use of BGS. By connecting central Båstad to Båstad sea promenade, an important wayfinding tool can be created. Students as well as residents passing through the space after school hours could be benefited.

Figure 2: *The disconnect between Lyckantorget and the sea prommenad, with Strandängskolan inbetween* (adapted from Ortofoto © Swedish Land Survey).

# 3.0 BACKGROUND

## 3.1 BACKGROUND LITERATURE

### Children's participation in design

When studying the development of school grounds as a landscape architect, children's participation must be particularly considered. Children are the main users and spend much of their time on school grounds (Dyment 2009). Since January 1st 2020, The UN Convention on *the Rights of the Child* is law in Sweden which further demonstrates how important it is to involve children in the process of design development (Regeringen 2017). It is now the law that the child's interest must come first in all decisions concerning children and children's right to influence. Furthermore, it is recognized that children's participation in design supports access to child-friendly outdoor environments, which is positive for several aspects of sustainable development (Malone 2001; Bjorklid et al. 2012). Designing with a child perspective is also a question of safety since vegetation can prohibit visibility and water can create life threatening risks (Göteborgs Stad & Ramboll 2017). A child perspective will therefore be part of the method used to study BGS.

### Benefits of naturalistic school grounds

Looking further into BGS as green or naturalistic features several studies have seen that access to greenery is specifically linked to a wide range of play settings and learning activities. Children's outdoor play on large and green school grounds has shown a correlation with better night's sleep, well-being, weight control (Söderström et al. 2013), and ability to concentrate (Mårtensson et al. 2009). Green school grounds function as places for nature contact (Maller & Townsend 2005), social interaction, and pretend play (Samborski 2010). These green areas are often the children's favourite places. Studies on green outdoor environments show how these landscapes facilitate the interaction between children across age, gender, and ability (Woolley et al. 2006; Dyment et al. 2009).

In addition, green school grounds with naturalistic vegetation, woodlands, and gardens can help children learn about the environment by offering a range of interconnected, direct, and action-oriented possibilities (Fägerstam & Blom 2013; Malone & Tranter 2003). Research shows positive effects and longer lasting knowledge of teaching when alternating between indoor and outdoor activities (Fägerstam 2012) as well as better academic results in school (Matsuoka 2010). Examples of outdoor educational environments include gardening opportunities, water facilities, and energy production (Boverket & Movium 2015). Dunnett and Clayden (2008) go as far as stating that humans have an attraction to water that stretches back into history where man lived a semi-aquatic life on the savannah around lakes and streams. Despite this, governmental regulations ensuring high-quality playgrounds only recommend "30m² per child in schools and

40m² per child in preschools" (Boverket & Movium 2015; Boverket 2021). The recommended space will therefore be utilized with a multifunctional approach.

Integrating BGS will naturally promote a more naturalistic school ground. The consequences are however increased wear and tear of vegetation which needs to be considered as part of design development, and especially in the establishment phase (Gunnarsson and Gustavsson, 1989; Gustavsson et al., 2005).

**Mottaghi study**

The thesis also builds on the conclusions of a study on BGS in Augustenborg, Malmö by Mottaghi et al. (2021). Eco City Augustenborg was an innovative project in Malmö proposed in 1998 focusing on climate goals such as stormwater management and creating sustainable regeneration after many years of unemployment and segregation in the area (Malmö Stad 2022). The study has recently showcased how BGS provide adequate affordance of play opportunities in Augustenborg. The results of the study indicate that affordances of play were recognized due to the varying nature of BGS. Actualized affordance of play was harder to accomplish in the study.

**Authority figures**

Authority figures role in the outdoor play of children is also important. Research shows that outdoor play increases children's ability to take physical risks and create social dynamics between children in relation to adults. Children in groups, as well as individuals, get to test their boundaries through play (Kylin 2004).

The study by Mottaghi et al. (2021) supports the important role authority figures play in the development of children. The children's pattern of usage was often controlled by adults in the study. If an adult did not recognise part of a landscape, the children had a harder time discovering the potential play value found there. Mottaghi et al. (2021) argues that without staying in a landscape, it would be hard to develop visual perceptions (Heft 2010, pg 10). According to Heft (2010), visual perceptions are found in the immediate view. It is therefore important that authority figures reside near BGS on school grounds so that children can develop visual perceptions.

Visual perceptions are also an outcome of an integrated spatial design (Mottaghi et al 2021). Expanded dimensions of play destinations and a dialogue and symmetrical relationship between different places are the other benefits of design integration according to the study by Mottaghi et al. (2021).

**BGS and ecological corridors**

BGS is green infrastructure combined with storm-water management in an urban environment. Examples include wet meadows, rain gardens, and gutters (Voskamp et al. 2015). Integrating BGS in school grounds has the potential to also provide play and learning opportunities. Studies show that natural elements can provide opportunities for play and learning. Many of these natural elements are also the building blocks of BGS: landform, vegetation, materials, moving/loose parts (Woolley and Lowe 2013).

Combining several BGS can form an ecological corridor working at a larger scale. Connecting BGS allows for linking spaces of vegetation and water between built environments that allows flora and fauna species to move, reproduce and colonize freely. The result of this is a green route for wildlife. The nature of BGS is that they are open systems and therefore form a visual addition to the landscape. Combined BGS can therefore act as a recreational wayfinding tool in the landscape (Dee 2001). BGS provide several functions in the urban fabric and therefore have a promising role in school grounds as well as a connecting tool between spaces.

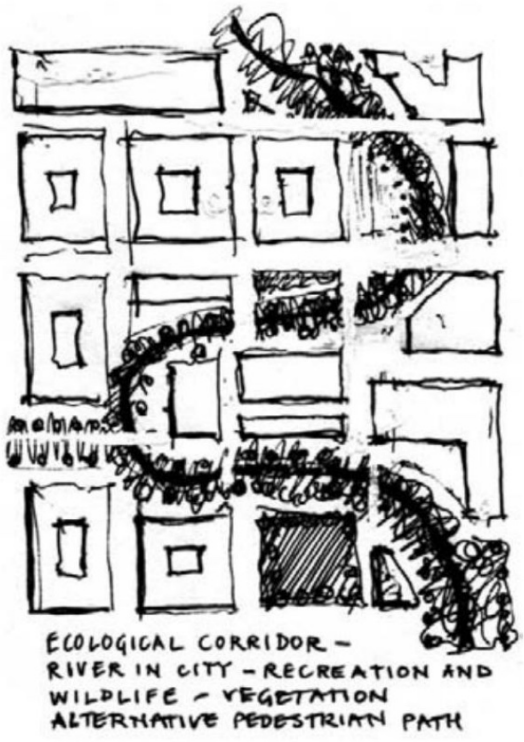



Image 2: *Sketch of an ecological corridor* (Dee 2001, pg 86).

## Topography

As previously described, landform is a building block of BGS. Landform is also an essential design tool for landscape architects. Landforms arrangement in a landscape creates topography. Topography is a space forming element which can create thresholds. For example, "passing between landforms can create a sense of separateness" (Dee 2001, pg 176). There is a clear connection between topography as a design tool as well as a building block of BGS that can promote affordances of play and learning (table 1). Topography will therefore be used to analyse the thesis as well as inform the design principles and proposal.

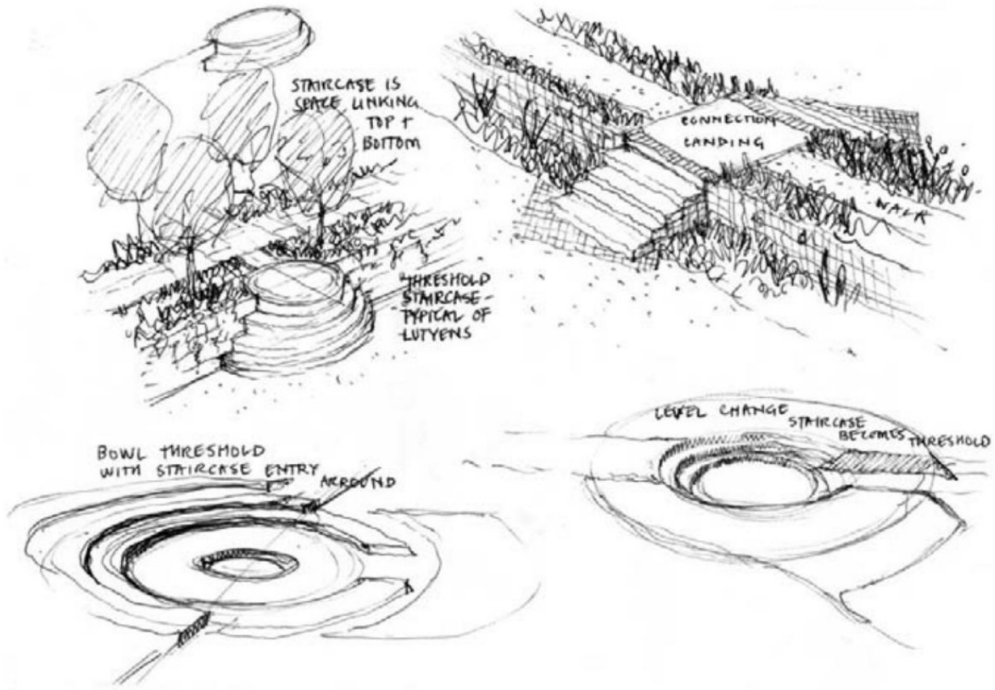



Image 3: *Topographic thresholds* (Dee 2001, pg 178).

## 3.2 THEORY

This study uses the affordance theory, and actualized affordance theory as well as the planning tool, zoning. How outdoor environments can create opportunity and actual use of play and learning opportunities is explored using affordance theories. In this study zoning is used to complement the findings based on affordance. Zoning supports the design process but is not a design theory. Zoning is applied to promote an inclusive design with varying types of affordances in the school ground.

**Affordance theory**

The affordance theory was originally introduced by Gibson (2014) and revolves around the concept that an environment can offer something to animals, including humans. Heft (1988) approaches Gibson's affordance theory by looking at physical affordances in the environment. He studied physical affordances of children and concluded that children are unusually good at perceiving affordances (Heft, 1988). Heft (1989) explains a difference between 'potential affordances' and 'actualized affordances'. There are several potential affordances in a landscape but there are less of actual affordances. Thus, promoting 'actualized affordances' in landscapes directed towards children is the bigger challenge when integrating BGS in school grounds.

**Affordance theory —> actualized affordance theory**

Table 1 summarizes the affordance theory as a tool to examine affordances of play based on the natural elements: landform, vegetation, materials, and moving/loose parts (Woolley and Lowe 2013). This table, created by the author and fellow students in a previous group work is based on an accumulation of studies looking at the affordance theory. The results from the study by Mottaghi et al. (2021) supports the accumulated research since the findings conclude how BGS can afford adequate play opportunities because they are made from the natural materials such as those described in table 1 (Mottaghi et al. 2021).

| Natural Element | Play opportunities – or play value |
|---|---|
| Landform | Excellent for physical play: changes in levels for climbing, rolling, jumping and sliding. It can also be adapted to provide a sense of enclosure and open, high and low spatial experiences. |
| Vegetation | Use of trees and shrubs within an environment can add aesthetic, creative and educational value. Can be used for dens or as an educational tool when teaching children about the environment and seasonal changes |
| Materials | Wood, water, sand, stones and vegetation can offer educational and creative stimulation. Boulders and rocks provide for physical, imaginative dramatic, social and fantasy play. |
| Moving/loose parts | Closely linked with the provision of materials, but beyond the stimulation of a tactile environment, moving/loose parts can enhance creative and imaginative play and allow a child the opportunity to interact with and make sense of their environment. |

Table 1: *A summary of the relationship between the natural environment and play* (Mitic et al. 2020).

Promoting actualized affordance requires other factors such as integrated spatial design and a non-hierarchical approach. Table 2 is a tool largely based on the findings of the Mottaghi et al. (2021) study and focuses on the theory of actualized affordance. A natural progression between table 1 and 2 is evident as a potential affordance needs to be recognised for actualized affordance to occur.

| **Promoting Actualized Affordance of play and pedagogical learning in BGS** | **Design Interventions** | |
|---|---|---|
| **Integrated Spatial Design** | BGS affordances are complimentary with other surrounding affordances, such as traditional play structures. | Promoting accessible BGS. |
| **Present Authority Figures:** | BGS are spaces that authorities also reside and stay in. An example of promoting this is to add seating in reference locations. | |

Table 2: *A summary of the relationship between actualized affordance of play and learning, BGS, and design interventions (*Mottaghi et al. 2021).

## Zoning

*The Tekniska krav och anvisningar, Technical requirements and instructions*, formed by Gothenburg municipality local administration (Eklund & Sandoval 2021) is a document based on local aims, but it is also based on regulations across Sweden including *Gör plats för barn och unga! En vägledning för planering, utformning och förvaltning av skolans och förskolans utemiljö* (Boverket & Movium 2015). The document covers zoning of playscapes and how to break up the landscape into green areas, active areas as well as calmer areas with the purpose to create varying affordances (Eklund & Sandoval 2021).

The zoning tool describes the natural elements found in different zones. Supporting research shows that these natural elements have a positive correlation to play and learning opportunities. Zoning can be used to help with design development and integrating BGS. Since similar natural elements are also what make-up BGS, zoning can act as a planning tool for designing with BGS. Different zones provide different play and learning affordances as well as different natural elements, as shown in the principal sketch in Figure 4.


Figure 4: *Principle sketch; zoning of a school-ground. F-3 & 4-6* (Eklund & Sandoval 2021).

In this zone the children feel a sense of freedom, space and infinity. There should be plenty of vegetation, including trees, where children can build, climb and get a sense of being in another world or just be alone. This zone contributes to 2/6th of the school grounds total area.

This zone contributes to 3/6th of the school grounds total area. Here there is plenty of space where children can move freely in many different directions and between many activities. In this zone children and teachers have a good overview of the area.

In this zone there are places to relax, be creative and build. This zone contains activities which often need an authority figures support. It is the zone that is closest to the building, but another creative and calm zone is also needed within the wild zone. The zone can for example be smaller rooms adjacent to each other. This design increases the feeling of safety amongst children. This zone contributes to 1/6th of the school grounds total area.

This zone is the area which welcomes both teachers, users, students, and visitors. This is the organization's first impression to the public and should be clear and informative. The entrance should be green with seasonal change and can have a personal touch which reflects the organization (Eklund & Sandoval 2021).

## 3.3 METHOD

Literature studies and document analysis, guided interviews with stakeholders, and an observational study in part guided by Play Environment Categories (OPEC) framework, was used as the method to answer my research questions.

Site observations and interviews with teachers at Strandängsskolan as well as looking at reference projects were conducted. I used other names in the text to protect the identity of the teachers I interviewed at Strandängsskolan. Conducting interviews with architects designing blue green school grounds as well as an interview and observations at Hyllivångsskolan have also been carried out. Sketching and designing was also part of the method to visualize both the analysis and findings. The method process is visualised in a diagram to the right.

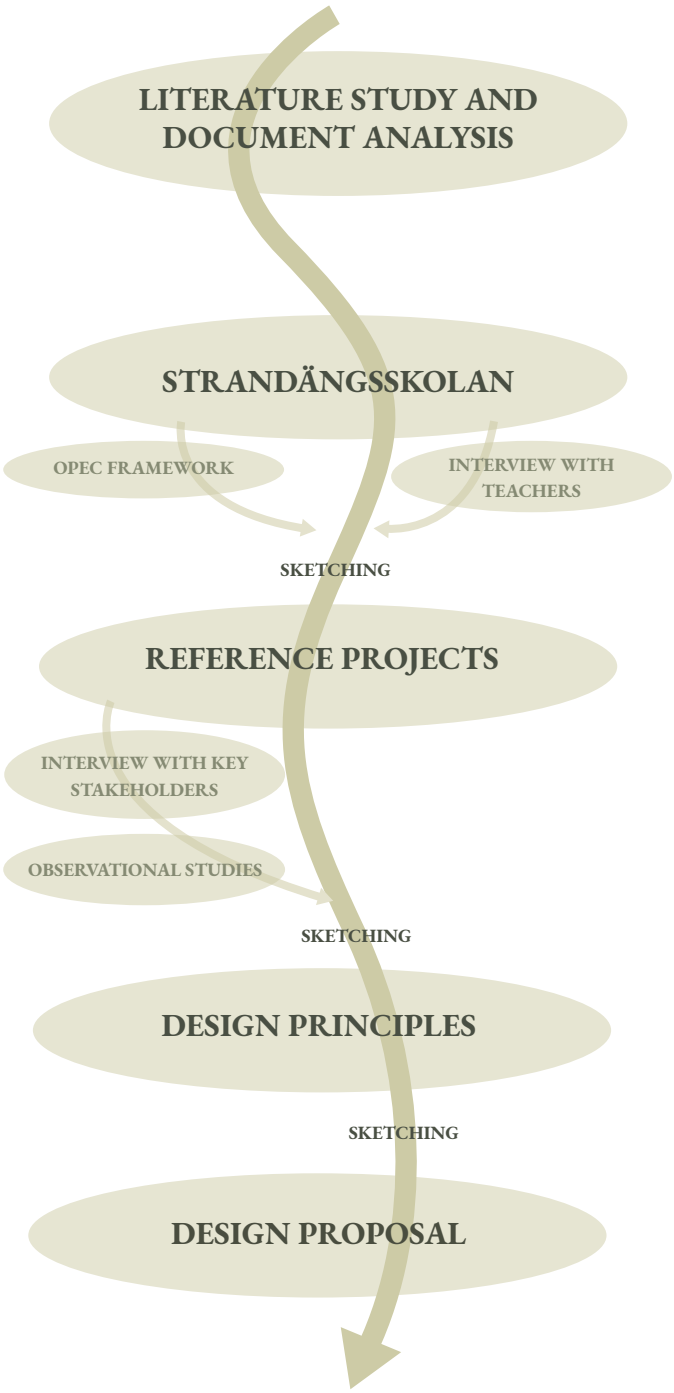



Figure 5: Method process visual.

## STRANDÄNGSSKOLAN

### Outdoor Play Environment Categories (OPEC) framework

A site visit was carried out to get a better understanding of the site as-is. OPEC, based on research and developed by Mårtensson (2013), was used to create an observational study of the site from a child perspective, as it was based on data from video-tracking children in different preschool settings (Mårtensson 2009; Mårtensson 2004) (see Appendix 1). It is widely acknowledged that professionals who understand children's perspectives can assist in making outdoor environments more child friendly (Björklid et al. 2012). Using OPEC on Strandängsskolan and taking the results into consideration was therefore one way to ensure the child friendlessness of the design proposal.

OPEC is used to determine the value of outdoor environments for children and asses what opportunity there is for health promoting play in that environment. OPEC can also be used as a tool for shaping good quality outdoor environments for children.

The OPEC environmental features are based on typical outdoor movement sequences (Mårtensson & Boldemann 2008). OPEC points to three dimensions: "total size of the outdoor area", "proportion of surfaces with trees, shrubbery or hilly terrain" and "integration between vegetation, open areas and play areas" and suggests that the more of these aspects exist, the higher the play potential of an environment such as a school ground. Several studies support that a high OPEC score improves the physical and mental health of children (Mårtensson 2013, pg 502-508).

### Interview with teachers

An interview over a video call was held regarding elementary school children age 6-12 from Strandängsskolan. The interview was carried out to study the teacher's perspective on how children utilize the existing school ground and how the school ground was accustomed to events of rainfall. Guiding questions were a starting point of the interview but continued into a flowing conversation. The questions were based on the affordance theories.

The interview was carried out in April 2022. The guiding questions revolved around the role of the interviewee and his and her experiences and observations of the school ground and the students when it rains (see Appendix 2).

## REFERENCE PROJECTS

### Interviews with key stakeholders

The stakeholders were chosen based on their relevance. The interviewees all played a key role in a reference project which has incorporated BGS in a school ground.

Interviews on video call were carried out with Stenberg, Landscape Architect at Link Arkitektur, Östman, Architect at Liljewall Arkitekter and, Lindskog, administrative manager at Hyllievångskolan. The interviews were carried out between April and May.

### Torslandaskolan

Torslandaskolan F-6 is in Gothenburg and has a vision of becoming "the world's best school when it rains" (LINK Arkitektur 2022). Torslandaskolan is set to be finished in 2024. The naturalistic approach sees rain as part of the outdoor environment and focuses on vegetation.

The interview with Stenberg at Link Arkitektur included guiding questions revolving around the details of Torslandaskolan as well as the challenges that come with integrating BGS in school grounds (see Appendix 3).

**Hyllievångsskolan**

Hyllievångskolan opened in August of 2017 and is located in between the city and the countryside providing many varying learning environments. The school is an F-6 school but is still in development and the school is set to be fully complete in 2023-2024 (Malmö Stad 2022). Iduns preschool is connected to Hyllievångskolan and opened shortly after Hyllievångskolan in May 2017. Iduns park is located adjacent to the two school grounds and functions as a neighbourhood park as well as an extension of the school grounds. BGS are incorporated in the F-6 school ground and the neighbouring park for both play and learning opportunities.

Interviews

The interview about Hyllievångsskolan in Malmö was carried out with Östman from Liljewall Arkitekter and Lindskog, administrative manager at Hyllievångskolan. The interview with Östman from Liljewall Arkitekter had guiding questions which revolved around the details of Hyllievångskolan as well as the challenges that come with integrating BGS in school grounds (see Appendix 4).

Lindskog is the administrative manager at Hyllievångskolan and she has been working at the school since it opened in 2017. The purpose of the walking interview was to hear about her perception of the school ground five years after it was constructed. I wanted to examine what conflicts and opportunities integrating BGS at Hyllievångskolan have created. By walking alongside the administrative manager, she had the opportunity to show details such as materials and vegetation. Lindskog had been provided with my project plan and understood my project aims but there were no guiding questions presented during this interview.

Observational studies

The observational studies at Hyllievångsskolan were based on the conclusions from the study by Mottaghi et al. (2021) on actualized affordance of play. The observations were carried out to examine how elementary school children, as well as authorities interact with the BGS in relation to play and learning. The movement of children and authorities were observed based on the theory of actualized affordance.

## Design Process

The design process involved sketching throughout the entire study. The sketching process has been carried out as a method to build on other methods. Sketching has also been used to design and produce the proposal made from digital images.

Sketching is how humans explore oneself, how they seek solutions (Nords 1995). In the case of this study, the solution was the design principles that helped form the proposal. The proposal combines research and design which is an important integration in landscape architecture as described by Jansson, Vicenzotti & Diedrich (2019).

# 4.0 RESULTS AND ANALYSIS

## 4.1 ANALYSIS STRANDÄNGSSKOLAN

### 4.1.1 OUTDOOR PLAY ENVIRONMENT CATEGORIES FRAMEWORK

Firstly, the OPEC site analysis looks at the total outdoor area accessible to children. In the case of this study, the area is compared to Boverkets recommendation of "30m$^2$ per child in schools and 40m$^2$ per child in pre schools" (Boverket & Movium 2015; Boverket 2021). According to Sara, a teacher at Strandängsskolan, the number of children on the school grounds varies throughout the day but most often there are around 3-4 classes with 35-50 students in each class outside playing at once. She later noted that there are often more students during lunch hours. Looking at this data and comparing it to the OPEC site analysis this part of the school ground has a mean of 43 students and 4 classes out playing at once. 172 students are on the 3000m$^2$ school ground at the same time. This means that approximately 18m$^2$ is given to each student between years F-F6. The results indicate that each child gets approximately 10-20m$^2$ less space than Boverkets recommendation. This result gave the score 2 out of 3 as part of the OPEC framework. These numbers should be considered when looking at the spatial design as one type of play affordance should not dominate over another in the proposal (see table 2).

Furthermore, the proportion of the area containing shrubbery, trees and hilly terrain is documented as part of the OPEC framework. This data can be analysed using table 1. Less than half of the area was identified as containing shrubbery, trees, or hilly terrain, scoring a 2 out of 3. It is evident from the literature study as well as the affordance theory that vegetation and landform contribute to play opportunities. These elements should therefore increase

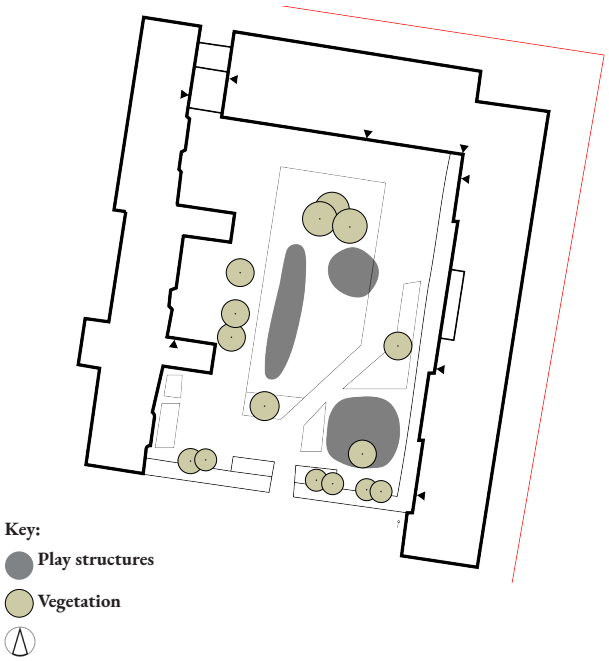



Figure 6: *Location plan showcasing the degree of integration between vegetation, open areas and play structures.*

in the proposal.

Next, the OPEC framework identifies the integration between vegetation, open areas and play structures which is also identified as promoting actualized affordance of play (figure 7). This is because integration of spatial design between different affordances creates more opportunities for actualized affordance of play in BGS (Mottaghi et al. 2021). The site scored a 2 out of 3 on the scale since the play structures are found adjacent to trees and shrubbery (see Appendix 1). Including more open space in between play structures would improve the score of the OPEC analysis in the proposal.

The play structures dominate the landscape. Vegetation is mainly found at the rim of the playground (figure 6). Vegetation is also a building block of BGS and would therefore increase if BGS were integrated at Strandängsskolan.

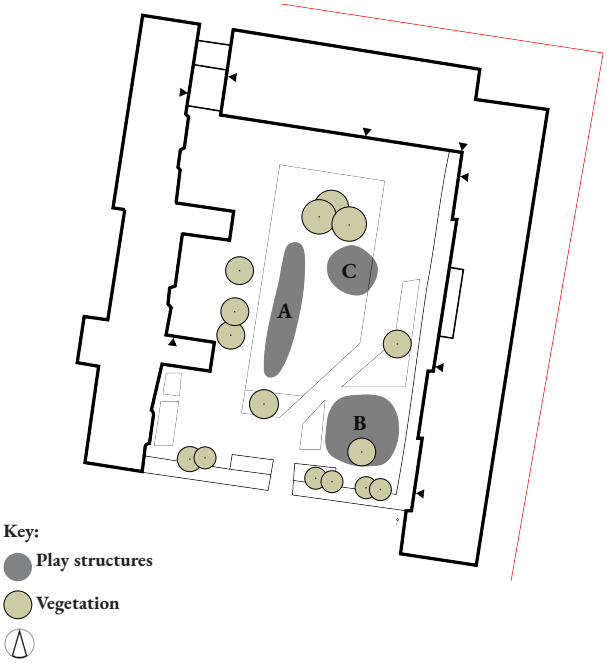



Figure 7: *Key showcasing the location of existing play structures.*

Image 4: *Play structure A, swing set and climbing structure.*

Image 5: *Play structure B, sandbox under sunroof and artifical grass hill with adjacent wooden deck and tree.*

Image 6: *Play structure C, climbing structure.*

### 4.1.2 INTERVIEWS WITH TEACHERS

#### Authority Figures

While interviewing one of the teachers at Strandängskolan, age comes up as a factor that influences children's play.

For older children, their play looks different. Emil mentions the way play changes as children get older: "I don't know why they stop [playing] when they get older, if it's because of the teachers or because of the students... if there is a specific type of jargon". He is referring to children's initiative to play. Play is an important part of the healthy development of children (Mårtensson 2013). Authorities' role in children's play is noteworthy in promoting actualised affordance of play and learning. Children are unusually good at perceiving affordances (Heft, 1988) and therefore actualised affordances need to be the focus. An example of encouraging actualised affordance is designing environments where authority figures choose to reside near BGS. Integrating benches in reference locations can promote this behaviour (Mottaghi et al. 2021) (table 2).

#### Water Play

When asked about particular elements that children enjoy, Emil says, "there is a pipe that is very popular". Sara adds: "It is not a gutter, but the water goes through and there is a hole at both the top and at the bottom of the pipe. They really enjoy playing there and interacting with it... making it collect water and then seeing the water rise in the pipe." Emil also mentions that they like the sandbox.[1]

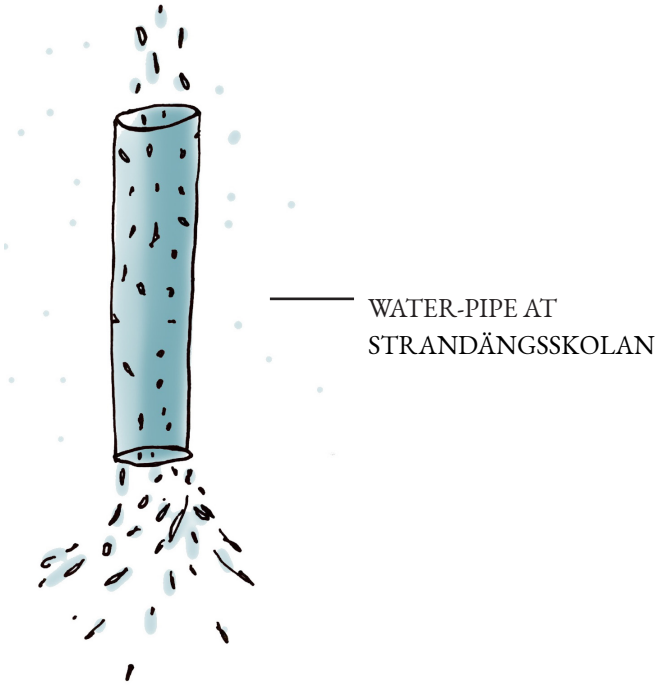



Figure 8: *Memories of water-play at Strandängsskolan*

1 Emil and Sara, Teachers at Strandängsskolan, interview 24 April 2022.

He adds saying: “water is one of the elements that is important... I believe in play that is less structured and where water can be present, he mentions.” What is evident here is that water play is some of the children’s favourite play opportunities on the school ground. Water and sand can provide creative stimulation as well as educational opportunities. Being able to follow the water’s journey through pipes and open systems, therefore promotes both creative stimulation and educational opportunities (see table 1). Enhancing the journey of water and integrating more of both water and sand should be carefully considered in the proposal.

Spatial Design

When asked about what they as teachers feel is missing from the school ground Sara says: “children want bushes and dirt and places with water, and rooms within rooms where children can hide. There is a lack of integrated vegetation to complement traditional play structures.” Emil says: “integrating water better to be able to promote play and learning opportunities is missing”. Certain topics were often repeated in our conversation which made it clear that enough green features including trees, bushes, water, or sand were missing (see table 1). These natural elements should thus be enhanced in the proposal.

A meeting place was also mentioned as a feature the teachers were missing. A new meeting place would promote a better integration between different affordances in the spatial design (see table 2). The design proposal should thus include a meeting place.[1]

Image 7: *Visualisation of Torslandaskolan stage and ampitheater between Open & Fast-paced Zone as well as Creative & Calm Zone* (Link Arkitektur & Göteborg Stad 2020)

1 Emil and Sara, Teachers at Strandängsskolan, interview 24 April 2022.

## 4.2 ANALYSIS OF REFERENCE PROJECTS

### 4.2.1 INTERVIEW WITH KEY STAKEHOLDERS

**Vegetation**

Stenberg, contributing landscape architect of the Torslandaskolan playground, describes how the use of vegetation helped LINK Arkitekter win the design competition for the school. She says that: "It was the integration of vegetation that made us stand out." LINK Arkitekter used vegetation to make a multifunctional landscape that provides both affordances for play and learning as well as ecosystem services. The Torslandaskola reference study clearly supports the aims of this study and confirms that lush BGS should be integrated in the design proposal.

**Wear & Tear**

Stenberg acknowledges that wear and tear of vegetation in a space designed for younger children can be a challenge. She describes how LINK Arkitekter overcame the challenge when integrating BGS: "A balance between a hard and soft landscape. In the zone with the wet woodland, a footbridge has been created which makes the area less fragile as a passage." Accessibility is also a design intervention that promotes actualized affordances of BGS (table 2). Therefore, accessible passages should also be incorporated in the proposal.[1]

Image 8: *Visualisation of raised boardwalk over stream at Torslandaskolan* (Link Arkitektur & Göteborg Stad 2020)

1 Stenberg, Landscape architect at Link Arkitektur, Interview 5 April 2022

Östman, architect for Hyllievångsskolan, made a relevant point about wear and tear. He says: “hard materials are also very important to consider, and this includes choosing durable material.” Östman mentions gravel seen at Hyllievångsskolan which is beautiful but requires regular maintenance. What I take away from this is even though hard materials can alleviate wear and tear of vegetation, the hard materials need to be chosen with careful consideration. Therefore, the interplay and choice of hard and soft materials needs to be carefully considered in the proposal.[1]

During our walking interview, Lindskog points out areas in Hylllievångsskolan where vegetation has been trampled and where, in areas, desire lines have been formed by children (see image 9 and 10). She says: “I have had to replace the fence once and still the children want to play amongst the young vegetation despite not being allowed.” Thus, thoughtfully integrating BGS in school grounds can still pose problems of wear and tear by children. Fencing around young vegetation had made somewhat of a difference and should therefore be considered in the proposal.[1]

1 Östman, Architect at Liljewalls Arkitekter, Interview 3 May 2022

1 Lindskog, Administrative Manager Hyllievångsskolan, Interview 29 April 2022

Image 9: *Fenced vegetation at Hyllievångskolan*

Image 10: *Desire lines at Hyllievångskolan*

## Spatial Design

At Hyllievångsskolan, the integrated BGS ditch has been used as a design element. Adapting to flooding as well as promoting play and learning opportunities due to the use of landform is one function of the feature. As described in table 1, the ditch promotes excellent physical play. However, the BGS ditch also provides a sense of enclosure with open, high, and low spatial experiences. Furthermore, it creates a threshold between the school ground and neighbourhood park.

Östman, architect for Hyllievångsskolan, describes how: "the ditch takes care of stormwater, provides for ecosystem services as well as forms a threshold between the school ground and Iduns park." In events of heavy rainfall, the ditch will fill up and create a border but when dry, which it is most often, it acts as a subtle threshold. Acknowledging the potential of BGS as design elements should thus be considered in the proposal for Strandängsskolan. This claim is supported by Dee who says: "landform is perhaps the most fundamental element in landscape architecture" (Dee 2001, pg 54).[1]

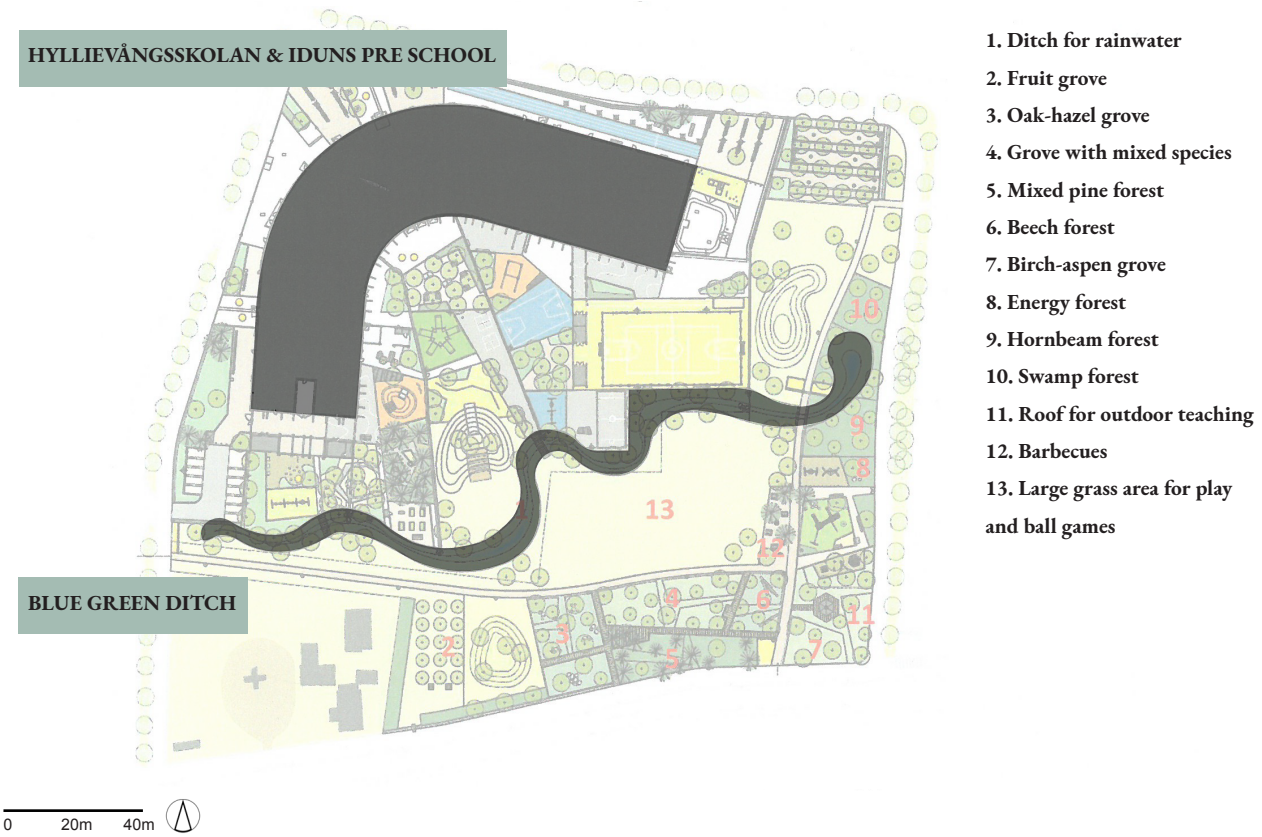



Figure 9: *Plan of Iduns park including: Hyllievångsskolan, Iduns preschool, and a blue green ditch* (Malmö Stad 2018)

1 Östman, Architect at Liljewalls Arkitekter, Interview 3 May 2022

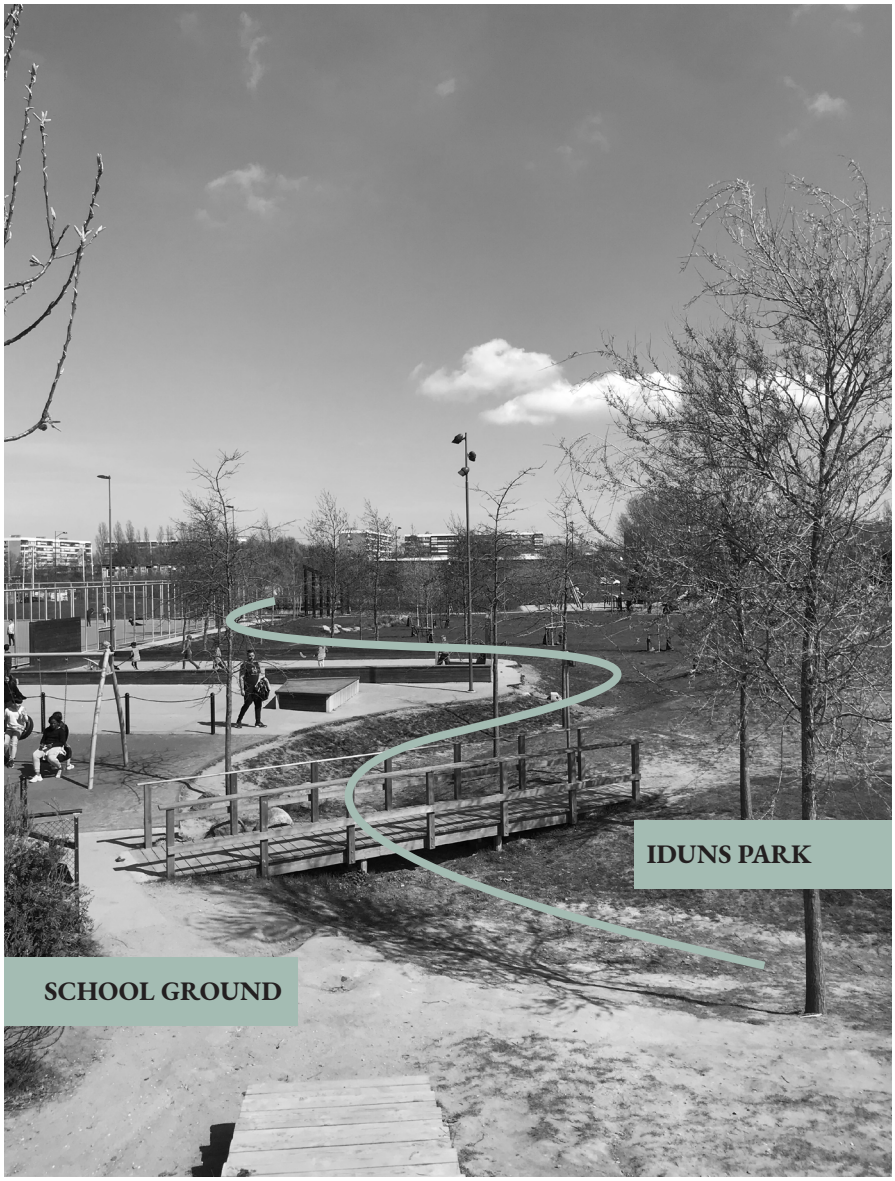



Figure 11: *Spatial design analysis - Hyllievångskolan*

## Indoor & Outdoor Learning

The outdoor classroom is depicted in several ways at Hyllievångsskolan. Östman describes how: "indoor and outdoor areas are connected by the sheds that are extended out from the main building." When walking with Lindskog it was clear that you could follow the journey of the water all the way from the roof where runoff water could search its way along the gutter to finally arrive at the BGS ditch. "The design also allows for teaching opportunities", Lindskog mentions. The physical connection between indoors and outdoors played into the aspect of promoting outdoor learning here. The journey of water can be demonstrated in various creative constellations with BGS as part of the design (table 1). The stormwater becomes accessible to the children through the paved stormwater gutters in the pavement along with the BGS ditch. By slowing down the waters journey it can become an important play and learning opportunity on the school ground. The journey of water should therefore be informed in the proposal to help bridge indoor and outdoor learning as well as provide learning opportunities (Boverket & Movium 2015).[1]

Image 12: *Stormwater gutter at Hyllievångskolan*

1 Östman, Architect at Liljewalls Arkitekter, Interview 3 May 2022

## Water as part of the school ground

Stenberg from LINK Arkitekter mentioned another reference project during the interview, Kilden barnehage, a preschool with high reaching climate goals. Our conversation revolved around the hesitation of integrating water on school grounds due to concerns about children's safety. Stenberg says: "the standard for water basins in projects is 20cm and in this case, we had it at 10 cm". The reasoning is that if the child falls on their back, water won't reach their ears. There are safe ways to integrate BGS, and where the children's best always come first. This construction regulation should thus be used in the proposal for Strandängsskolan.[1]

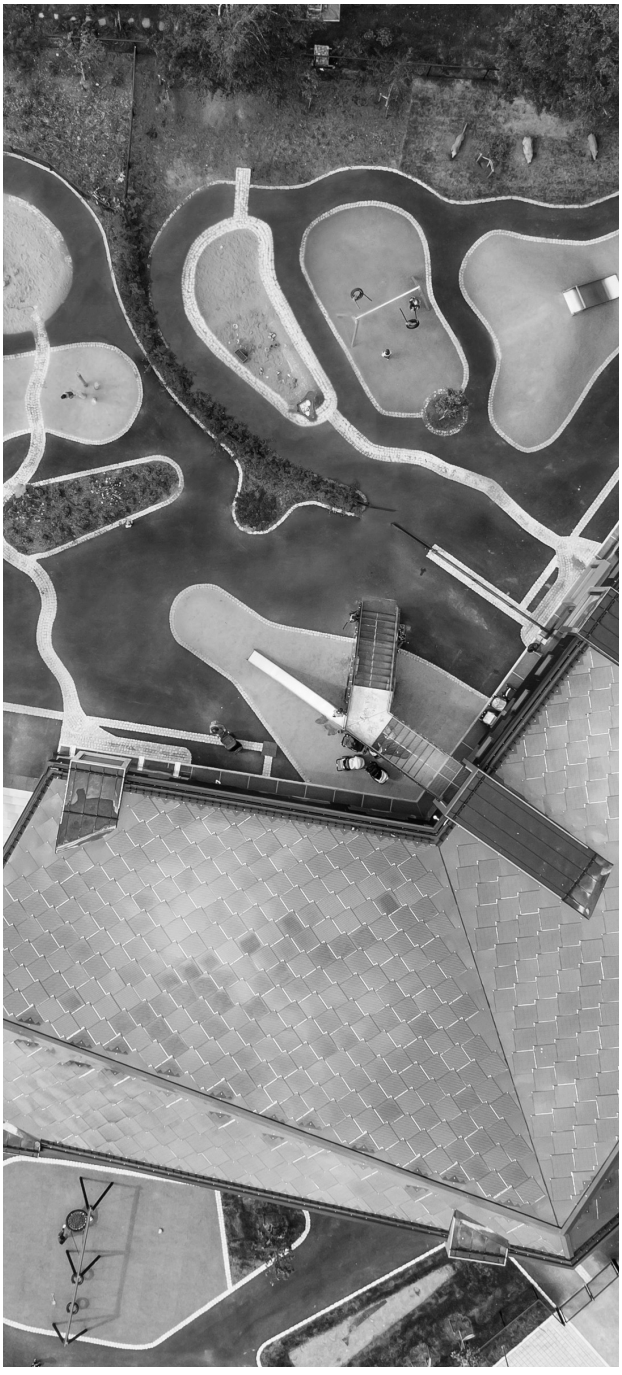


Image 13: *Plan of Kilden barnehage* (Link Arkitektur 2022)

1 Stenberg, Landscape architect at Link Arkitektur, Interview 5 April 2022

### 4.2.2 OBSERVATIONAL STUDIES - Hyllievångskolan

## Integration of play features

The ditch had several scattered trees and some boulders. Lindskog mentioned that: “the children thoroughly enjoyed digging here.” It was clear that there were holes in the ground where the children had played with the loose material. More loose material and vegetation has the potential to increase both the potential and actualized affordance of play and learning as well as lessening the damage of this BGS (see bottom sketch). The neighbouring swings and other more structured and traditional play opportunities were however dominating the school ground in many ways (see top sketch). It should also be noted that the ditch acts like a threshold and it was unclear how much the children were allowed to play on this feature. Regardless, the bridge made the BGS more accessible than it would have been otherwise (see middle sketch and table 2). Ensuring accessible BGS are formed should therefore be carefully considered in the proposal since it in this case took away from the positive design function of the threshold.[1]

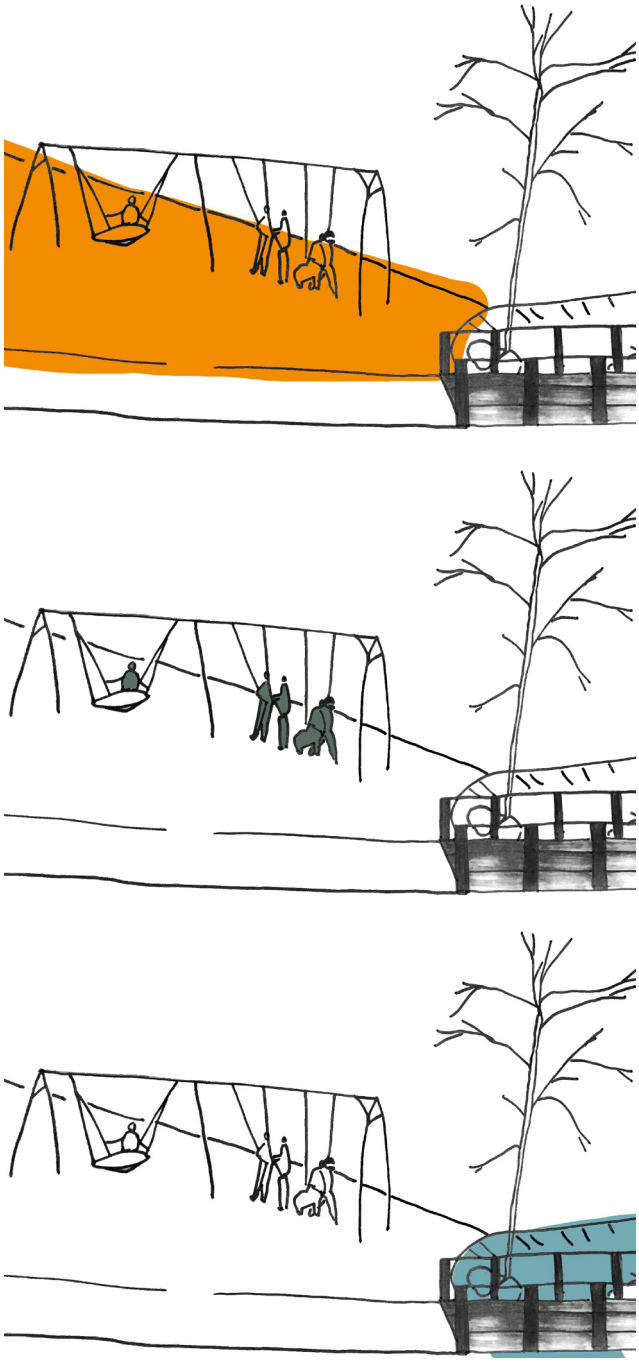


Figure 11: *BGS Observations at Hyllievångskolan*

1 Lindskog, Administrative Manager Hyllievångsskolan, Interview 29 April 2022

## Accessible BGS for authority figures

The relatively shallow ditch, approx. 20 cm is accessible to F classes and upwards. The children are not allowed past this threshold during school hours, making it relatively inaccessible as a play destination for the most part (figure 12). The lack of benches near the BGS would also hinder authorities and in turn children to reside near the BGS ditch even after school hours (table 2). Providing benches with sight lines in reference locations could help improve actualised affordance of play and learning at Hyllievångsskolan. The observational studies thus strengthen the need for accessible BGS at Strandängsskolans redeveloped school ground.

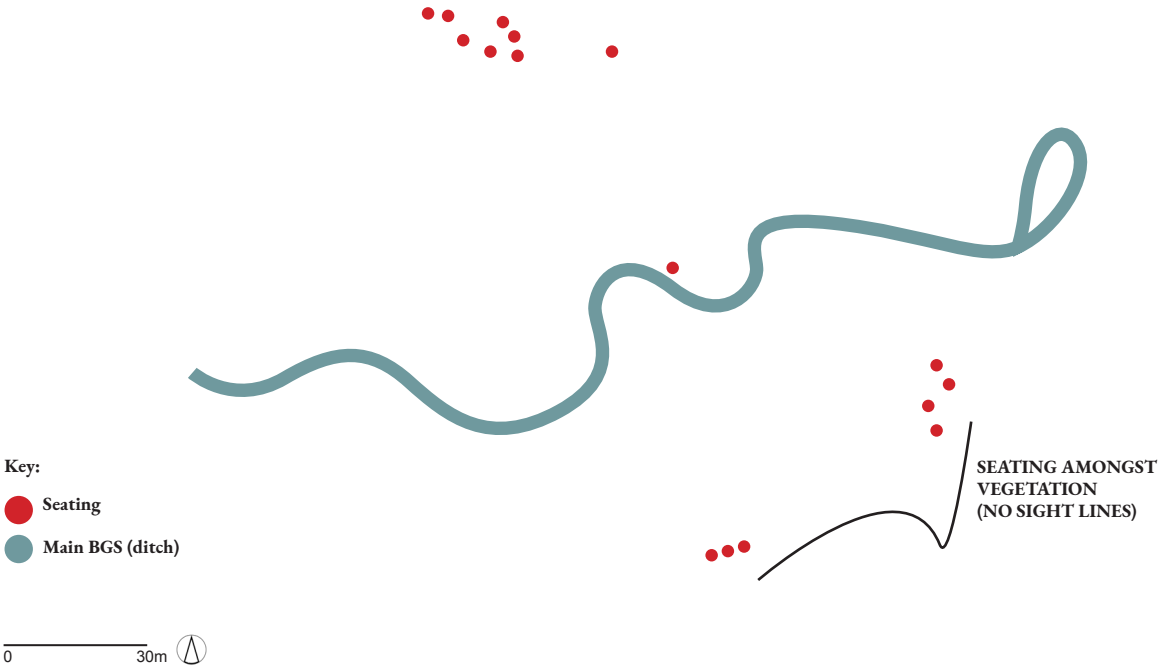



Figure 12: *Location plan of BGS seating at Hyllievångskolan* (Ortofoto © Swedish Land Survey)

# 5.0 DESIGN

## 5.1 DESIGN PRINCIPLES

Presented on the following pages, are design principles based on the research carried out in this thesis. The principles are based on data from the literature and document analysis, the site analysis, interview with teachers at Strandängsskolan, interview with key stakeholders from reference projects as well as observational studies from reference projects. Zoning as a planning tool, the affordance theory and actualized affordance theory, topography as a design tool as well as sketching were all used to analyse the interviews and observations during the study. The refined design principles have been formed to guide the final proposal for Strandängsskolans school ground. The design proposal is a response to the research question: How can stormwater management provide opportunities for play and learning? And the sub-question: How can stormwater management be applied in a proposal for Strandängsskolan that provides opportunities for play and learning? The following section will introduce the design principles. The 10 design principles are then summarized in a three-part design proposal.

Key:
A = BGS application to play and learning opportunities
B = BGS application to ecosystem services

## 1. Integrate BGS in the surroundings of the project site.

A. A larger area of green infrastructure will promote less hierarchy between play structures as the room is freed up for BGS to complement traditional play structures. An integrated spatial design promotes affordance and actualized affordance of play and learning opportunities. Implementing BGS in the surroundings of the site allows for a BGS ecological corridor to be established. A BGS ecological corridor will act as a wayfinding tool along the disconnected area of Båstad.

B. A BGS ecological corridor can hold larger bodies of water in the event of an extreme event with heavy downpour. A safe green route for wildlife, increased climate control and improved air quality are other ecosystem services that would benefit from a widespread green infrastructure network.

## 2. Increase shrubbery, trees, and hilly terrain by integrating BGS.

A. Shrubbery, trees, and hilly terrain (landform) are building blocks of BGS and promote affordance of play and pedagogic learning.

B. Implemented shrubbery and trees support increased biodiversity, climate control, and improved air quality

## 3. Create open spaces located in between BGS play features and traditional play features.

A. Open spaces located in between play features promote play opportunity as well as an integrated spatial design with varying affordances.

## 4. Create accessible BGS by, for example, implementing hard material primary pathways.

A. Accessible BGS promote actualized affordance of play and learning opportunities.

B. Accessible BGS allow young vegetation of BGS to establish. Habitats will be let alone increasing biodiversity and other ecosystem services such as climate control, biodiversity, and improved air quality.

## 5. Create conditions for authority figures to reside close to BGS by, for example, implementing benches in reference locations.

A. Authority figures residing near BGS promote actualized affordance of play and learning of children.

## 6. Incorporate hardy species and temporary fences so that wear and tear of BGS is reduced during the establishment period.

A. For BGS to thrive, sufficient establishment is necessary for affordance and actualized affordance of play and learning to take place.

B. Successful establishment of BGS will allow for more ecosystem services to take place in the long run.

## 7. Showcase the journey of water with the use of BGS.

A. Following the journey of water all the way from roofs to the BGS themselves will help bridge indoor and outdoor learning as well as promote learning opportunities.

## 8. Implement an outdoor meeting space.

A. The design principle will encourage an integrated spatial design with varying affordances to promote actualised play and learning opportunities.

## 9. Use landform, vegetation, materials, and moving/loose parts as part of the design language.

A. Natural elements promote affordance of play and learning opportunities and can also be utilized for site-specific designing.

## 10. Implement 10cm deep BGS for F-1 to F-6 outdoor areas.

A. Implementing safe BGS on school grounds puts the child's safety first at all costs whilst being able to introduce BGS for younger children.

## 5.2 DESIGN PROPOSAL

The design proposal is based on a concept with three strands which can be followed throughout the design.

**Naturalistic**
A green school ground with varying play and learning opportunities as well as a wayfinding BGS ecological corridor.

**Multifunctional**
A multifunctional school ground that doesn't compromise on ecosystem services, outdoor play and learning opportunities or site-specific design.

**Accessible**
A safe and inclusive school ground for young children and their authority figures.

### CONCEPT

The concept is **"A naturalistic multifunctional and accessible school ground that encourages actualized play and learning as well as a wayfinding ecological corridor".** The proposal has a core starting point of providing a school ground with play and learning opportunities from the integration of BGS. The concept is a response to site-specific challenges at Strandängsskolan and uses the design principles curated from the results of the study.

## ZONING


Figure 13: *Zoning Map of Strandängsskolan* (Adapted from Ortofoto © Swedish Land Survey).

The zoning planning tool has been applied as part of the design development. The zoning plan for Strandängsskolan has been used as a starting point for the design as visualised in figure 13.

**Wild & Naturalistic Zone**
Located furthest from the buildings, this zone will be the most wild and naturalistic. This area is located at a lower point on-site and will play an important role in infiltrating, cleaning, and delaying stormwater from both runoff of the school building and water making its way down from the city center through the ecological corridor.

**Open & Fast paced Zone**
This zone is vital in terms of allowing open space to complement dedicated play and learning opportunities. It is also an important pass-through space as the new ecological corridor will take up open space from the existing school ground design.

**Creative & Calm Zone**
This zone is designated to the F-F6 school ground and the younger children. This is the zone where teachers play a larger role in the involvement of play and learning opportunities. In this zone there is opportunity to relax, be creative as well as build. A requested meeting space will also be formed in this zone.

## BGS STRATEGY

The design proposal integrates BGS using the concept, design principles as well as zoning plan (see figure 14). This includes a half-open wet meadow, raingarden, and paved stormwater gutter that provide opportunity for affordance and actualized affordance of play and learning.

Firstly, the half-open wet meadow in the wild & naturalistic zone represents a biotope that can both delay and infiltrate stormwater which is flowing along the wayfinding ecological corridor and connecting the city's sports area, and main square, Lyckantorget.

Secondly, by proposing raingardens in the open & fast paced zone, stormwater is purified through infiltration beds with plants. The plants are perennials that can survive both dry and damp conditions. The raingardens will be important in connecting BGS together and forming the BGS ecological corridor.

Finally, the paved stormwater gutter in the creative & calm zone will slow down water runoff from the buildings to the north most point of the sandbox with existing mature trees. Water will be able to infiltrate into the sandbox during extreme weather events.

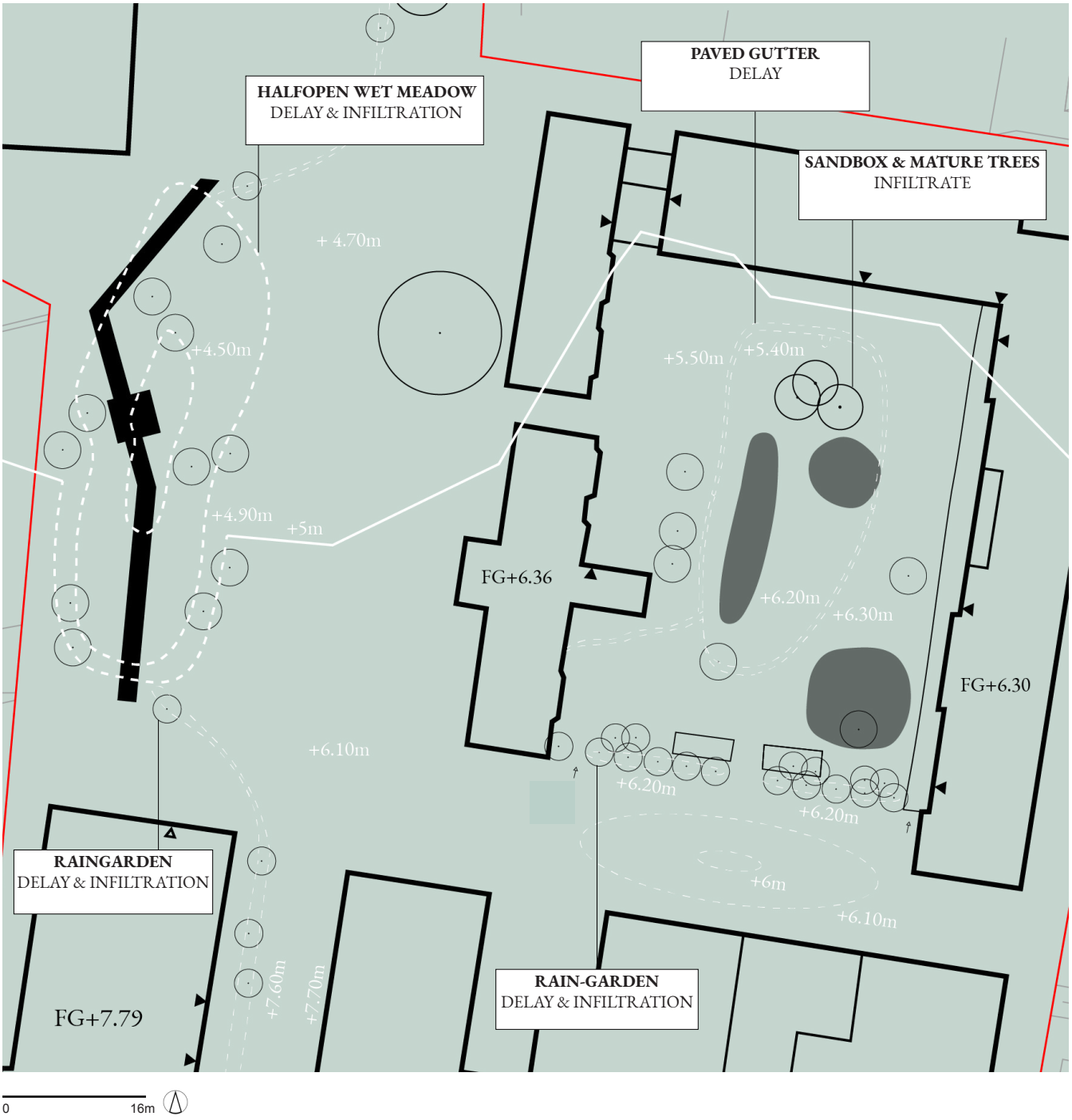



Figure 14: *Topograpy plan of Strandängsskolan*

## MASTERPLAN

On the following page, the masterplan visualizes how the design proposal will look in a constructed design. The plan focuses on depicting the integrated BGS and how they interplay with play and learning opportunities. The site-specific design choices refer to the concept which is built on the three strands: naturalistic, multifunctional, and accessible.

The half-open wet meadow with trees in groups of two provide for possibilities of immersion where there are also building and climbing opportunities (Eklund & Sandoval 2021). The raingardens provide topographical changes in landform together with other natural materials such as vegetation and water which create opportunity for play and learning (table 1). A raingarden has also been used to create a threshold between the F-F6 school ground and remaining school ground due to the changing landform (Dee 2001). The paved stormwater gutter follows the waters journey. Learning as well as play opportunities are promoted here considering that water, sand, and vegetation are all present in the creative & calm zone (Boverket & Movium 2015; table 1). Including the meeting place in the creative & calm zone contributes to an integrated design by providing a dialogue and symmetrical relationship between different places (Mottaghi et al. 2021). Open spaces have been implemented and the retention area is an example of this. Integration between open spaces, vegetation and play areas in separate parts of the environment are important to promote play opportunities as well as an integrated spatial design with varying affordances (Mårtensson 2013; Mottaghi et al. 2021).


Figure 15: *Masterplan of Strandängsskolans design proposal*

## CENTRAL SECTION ELEVATION

Figure 16 is a section elevation which visualises the most vegetated area of the school ground where two central features meet in the wild & naturalistic zone. The half-open wet meadow is a BGS with play and learning opportunities. The meadow meets with the wayfinding ecological corridor and acts as a passage that connects central areas in Båstad. The meeting place in the creative & calm zone is also represented and contributes to an integrated design. The meeting place was a missing feature according to F-F6 teachers at Strandängsskolan and is therefore located in the designated F-F6 school ground. Valuable features of the existing school ground have also been kept such as the pictured mature *Populus tremula* with proposed seating underneath.

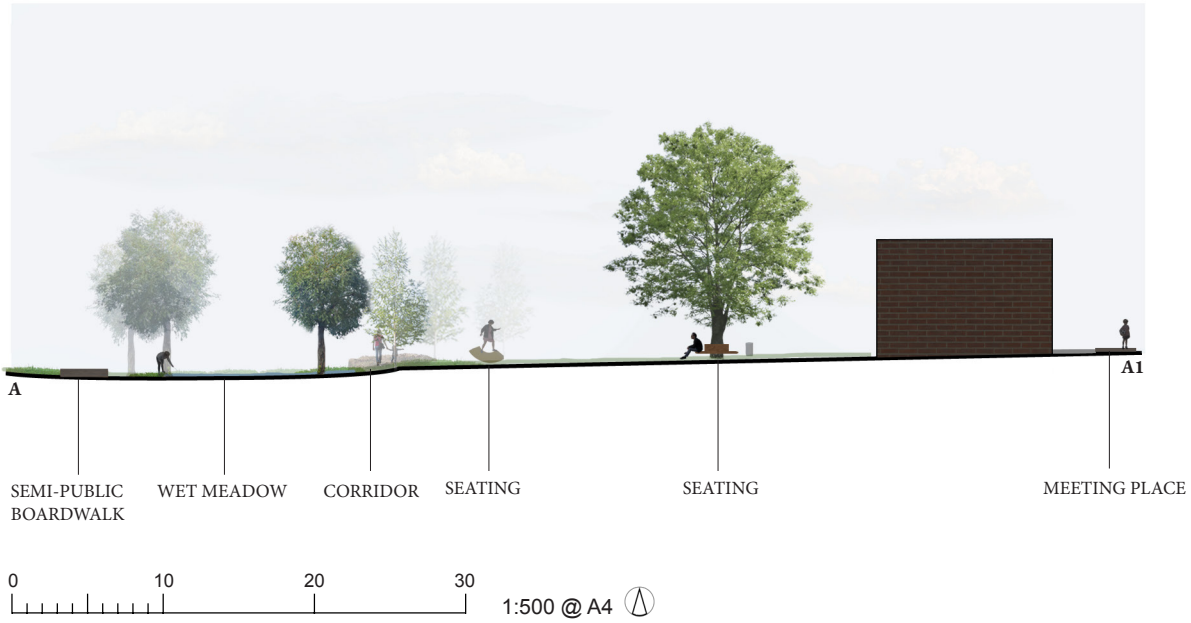



Figure 16: *Central section elevation of Strandängsskolans design proposal*

# 6.0 DISCUSSION

## 6.1 RESULTS DISCUSSION

The aim of this paper was to investigate how BGS can create opportunities for play and learning as well as how the findings could be integrated into a design proposal for the redevelopment of Strandängsskolans school ground. The proposal aims to provide "a naturalistic multifunctional and accessible school ground that encourages actualized play and learning as well as a wayfinding ecological corridor" and is based on the 10 design principles curated from the thesis.

The headings below show the many benefits of constructing the proposal.

**Naturalistic**
Aim: A green school ground with varying play and learning opportunities as well as a wayfinding BGS ecological corridor.

The design proposal has increased shrubbery, trees, and hilly terrain by adding BGS into the design of Strandängsskolan. These natural elements are also building blocks of BGS and promote affordance of play and pedagogic learning. The proposed half-open wet meadow and rain gardens support and increase biodiversity, climate control and air quality. A proposed design with open areas will create an integrated spatial design with varying affordances. Widespread areas of BGS have made way for a BGS ecological corridor. The proposed corridor is connecting central areas of Båstad using raingardens. The BGS ecological corridor will act as a wayfinding tool along the disconnected area of Båstad as well as promote an integrated spatial design by complementing existing traditional play structures. The corridor will be able to hold larger bodies of storm-water as well as aid in several ecosystem services. If a future construction, planting, or management plan is constructed hardy species and temporary fences are highly recommended as part of the proposal. Sufficient establishment is necessary for BGS and ecosystem services to thrive.

**Multifunctional**
Aim: A multifunctional school ground that doesn't compromise on ecosystem services, outdoor play and learning opportunities or site-specific design.

A proposed meeting place is added in the proposal. The role of the meeting place is to encourage an integrated spatial design where affordances are varied. The design suggests a construction that showcases the journey of water using BGS. This addition to the school ground affords learning opportunities as well as a connection between indoor and outdoor learning. A raingarden is also proposed and acts as a BGS as well as threshold between the F-F6 school ground and remaining school ground. The soft threshold replaces the wood plank that created an unwanted harsh border. Landform has been used to create a site-specific design. Landform is also a natural element which promotes affordance of play and learning opportunities.

**Accessible**
Aim: A safe and inclusive school ground for young children and their authority figures.

The proposal has suggested hard material primary pathways across BGS. The boardwalk crossing the half-open wet meadow as well as the path between the two school ground areas are made from hard materials. The pathways create accessible BGS that promote actualized affordance of play and learning.

Accessible BGS also allow young vegetation to have a chance to successfully establish. Established BGS will increase ecosystem services as a result. Inclusive seating near BGS is also proposed with an aim to increase actualise affordance of play and learning. The BGS in and around the F-F6 school ground are no deeper than 10cm. The half-open wet meadow located in the remaining school ground is not deeper than 20cm. By following construction recommendations, BGS can be established whilst putting the childs safety first.

The thesis demonstrates how to successfully combine BGS and school grounds. Ultimately, the two structures strengthen the function of one another. Decreasing urban space for children is creating a bigger need for more multifunctional spaces (Kylin & Bodelius 2015). The proposal offers a multifunctional school ground with integrated BGS that provide play and learning opportunities as well as ecosystem services. Play and learning conditions contribute to the healthy development of children whilst ecosystem services help face the challenges of climate change.

From a design perspective, the integration of BGS at Strandängsskolan was straightforward. Landform, for example, performs as a design tool as well as a building block of BGS in the proposal. Imagine if an entire city were to design school grounds with BGS. Perhaps the overall pedagogic nature of school grounds would improve compared to today. A generation that grows up playing and learning amongst BGS may also become more inclined to promoting and designing sustainable cities when they are adults.

The design principles were also formed as a tool for integrating BGS in future school grounds. School grounds are becoming smaller which can pose problems when integrating BGS. Strandängsskolans F-F6 school ground, for example, offers 10-20$m^2$ too little space per child. To combat this an integrated spatial design has been formed and the BGS have been incorporated across the entire school ground. An integrated spatial design is important so that visual perceptions are encouraged, and expanded dimensions of play destinations are formed (Mottaghi et al. 2021). The zoning planning tool also demonstrates the importance of varying affordances on a school ground (Eklund & Sandoval 2021). Both traditional play structures and BGS provide valuable play and learning opportunities. In other words, actualized affordances of play and learning increase with an integrated spatial design. The design principles can therefore also be applied to small school grounds. It is however important that an integrated spatial design is also formed which is generally easier on a large school ground.

The design principles should also be adapted to the site. The amount of stormwater that the BGS can take care of depends on the size of the school ground as well as the local site and its accompanying challenges. A site analysis should therefore be carried out before the design principles are applied. Using all the principles are not necessary to create a school ground that combines BGS with play and learning opportunities. The aim of the design principles is to promote more school grounds to integrate BGS, including Strandängsskolan as well as showcase the need for larger and greener school grounds.

## 6.2 METHOD DISCUSSION

The background research on outdoor play and learning for children as well as stormwater management was easier to source than material on the integration of BGS on school grounds. To keep the study focused I refrained from going into detail about the technical aspects of stormwater management. The focus of the paper was on the relationship between BGS and play and learning opportunities to answer the research question: How can stormwater management provide opportunities for play and learning?

The study by Mottaghi et al. (2021) was an important reference of the thesis. The observational studies at Hyllievångsskolan were based on the conclusions on actualized affordance in the study by Mottaghi et al. (2021). Table 2 also summarizes the conclusions from the study and is used to analyse the findings. The study by Mottaghi et al. (2021) analyses the outdoor environments of Augustenborg, Malmö. The neighbourhood is a sustainable regeneration project with many integrated BGS (Malmö Stad 2021; Malmö Stad 2022). The studied environment can be viewed as playscape, but it is not school ground. Families are primarily described as the stakeholders in the study which could be a limitation of the thesis. This is especially relevant when discussing authority figures. The relationship between children and parents is likely to be different compared to the relationship between children and teachers. The study by Mottaghi et al. (2021) still performs its function by providing a recent starting point for how BGS can promote affordance and actualised affordance of play in outdoor urban environments. As a result, the thesis builds on the study and its conclusions.

The thesis has been used to form 10 design principles. The principles have been curated as a tool for both Strandängsskolan and future school grounds. As a result, the principles are broad and may not apply to all school grounds. In the case of Strandängsskolan, the authority figure principle is only applicable when discussing the semi-public ecological corridor where parents are seen as the main authority figures (Mottaghi et al. 2021). Principle 5 is therefore only relevant on this part of the school ground. All school grounds may not have semi-public or public areas, making this principal niche and hard to apply to all school grounds.

Furthermore, I used the OPEC framework to analyse the site at Strandängsskolan (Mårtensson 2013). The framework from the child perspective was a successful tool in defining parts of the school ground that should be kept and parts that should be changed. All my results, however, scored 2 out of 3. The OPEC tool was in this case too vague in its scoring scale even though it provided valuable information that complemented the scores. Because the OPEC framework is a carefully curated tool based on research it was used and helped form a reliable site analysis of Strandängsskolan.

Sketching was used to both visualise and analyse the findings in the study. Sketching was also used to produce the design proposal for Strandängsskolan. Sketching was a necessary tool and helped bridge the gap between research and design (Jansson, Vicenzotti & Diedrich 2019). The observational studies were visualized through sketching. More observational studies using sketching could have strengthened the findings. Getting permission to take photographs and study the behaviour of children at the school grounds was however difficult

and limited the study. This is also the reason why interviews with children could not be carried out. The OPEC framework therefore played a key role in adding a child perspective as part of the method. This in itself could also be seen as a limitation.

The design proposal for Strandängsskolan is only one example of a suitable design for the site. Båstad municipality and Landskapsgruppens working proposal for Strandängsskolan supports this claim. The thesis proposal varies from Båstad municipality and Landskapsgruppens proposal even though both have used zoning as a planning tool. BGS can promote affordance and actual affordance of play and learning but are not necessary to do so. This reference does however demonstrate that BGS can be integrated on a school ground and still align with planning tools such as zoning.

## 6.3 FURTHER RESEARCH

Challenges of implementing the design principles into projects include a lack of technical specifications. Technical solutions are often site-specific which could have been interesting to investigate as part of the study. Technical research on BGS and the site is therefore something that could be researched looking forward. Furthermore, the funding and management of the proposal is not specified. Investigating how other stakeholders view a project like Strandängsskolan would be interesting to research further. As a landscape architect projects are never finished. A management plan with input from different stakeholders could help provide a successful design in the long term. Finally, the materials of the study are not researched in depth. The proposal is not a detailed plan and therefore research into appropriate and durable materials is not included. Materials for construction as well as vegetation could therefore be an interesting study topic in the future (see Appendix 6).

As mentioned in the results discussion and method discussion, the representation of authority figures could be seen as a limitation of the study. Further research could be carried out to study the difference in the relationship between children and parents as well as children and teachers regarding play and learning opportunities on green school grounds.

More observations as well as interviews with children could bring further insights as well as a stronger child perspective. Conducting alternative ways to study children's interaction on school grounds would contribute to deeper understandings of actualized affordance of play and learning opportunities on green school grounds.

## 6.4 CONCLUDING WORDS

More school grounds can benefit from integrating BGS. Landscape architects have the resources and skills to implement more multifunctional landscapes in urban areas. School ground's ability to be multifunctional should be utilized more and give added reason for larger and greener school grounds where play and learning opportunities for children and BGS can thrive in symbiosis. The hope is that this study can be used by landscape architects and neighbouring fields to strengthen the research as to why and how BGS have a place in school grounds, with Strandängsskolan as an example.

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# 8.0 APPENDIX

**Appendix 1:**
**Outdoor Play Environment Categories (OPEC) framework**

Outdoor Play Environment Categories, OPEC. Environmental categories used to evaluate the play potential of outdoor setting from 1 point to 3 points, with 1 point for setting with the lowest quality and 3 points for the ones with the highest quality (Mårtensson 2013).

## Outdoor Play Environment Categories (OPEC)

| | |
|---|---|
| **A.** | **Total size of the outdoor area:** |
| 1 point | < 1200m$^2$ |
| 2 points | 1200-3000 m$^2$ |
| 3 points | > 3000 m$^2$ |

*alternative*

| | |
|---|---|
| 1 point | < 2000m$^2$ |
| 2 points | 2000-6000 m$^2$ |
| 3 points | > 6000m$^2$ |

| | |
|---|---|
| **B.** | **Proportion of surfaces with trees, shrubbery or hilly terrain:** |
| 1 point | Little/non-existent |
| 2 points | < half of the area |
| 3 points | ≥ half of the area |

| | |
|---|---|
| **C.** | **Integration between vegetation, open areas and play areas:** |
| 1 point | No integration. Open spaces, vegetation and play areas in separate parts of the environment. |
| 2 points | Either of the following characteristics<br>a) trees or shrubbery are adjacent to play areas<br>b) the open spaces are located in between the play areas |
| 3 points | Both 2a and 2b above is full-filled |

Note. The two alternative ways of evaluating the size of the area is adjusted to the variation of environmental quality in the regions where studies have been carried out.

**Appendix 2:**
**Interview with teachers**

1. Who are you and what is your role at Strandängsskolan?

2. What happens when it rains at Strandängskolan? What do the students do? What happens to the school?

3. Do you recall specific interactions with rain by students?

4. Are there any places on the school ground where rain tends to collect?

5. Is there anything that you feel is missing in terms of play and pedagogic learning resources as it looks right now?

**Appendix 3:**
**Interview with architect - Torslandaskolan**

1. Who are you and what is your role at LINK Arkitektur?

2. Could you tell me about the project at large?

3. Have you considered wear and tear of vegetation in regards to children?

4. How have you dealt with designing with water and its concern with childrens safety?

5. What is your favorite part of the design proposal?

**Appendix 4:**
**Interview with architect - Hyllievångskolan**

1. Who are you and what is your role at Liljewall Arkitekter?

2. Could you tell me about the project at large?

3. What were the reasoning behind the ditch as a functional element and as part of the design?

4. How have you dealt with designing with water and especially taking this open approach to a border-less school-ground?

5. What was the plan for wear and tear of vegetation especially on the school-ground? I observed on-site that the fencing around young vegetation had been replaced and that children had still played amongst this vegetation despite not being allowed to.

6. How have you dealt with responding to pressurized urban space when designing Hyllievångskolan and Iduns Park?

5. What is your favorite part of the design proposal?

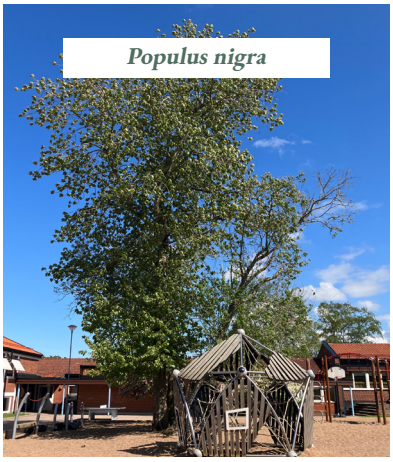
**Appendix 5:**
**Observational studies - Hyllievångskolan**

1. What is the movement of the children in relation to other parts of the school ground?

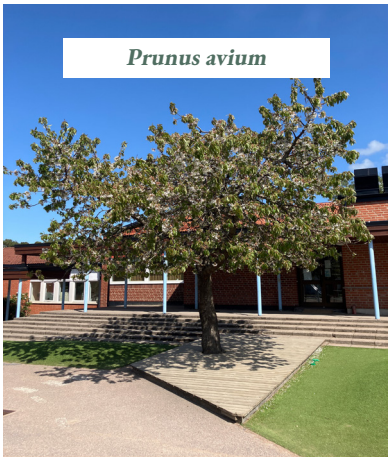
2. How are children accessing the BGS?

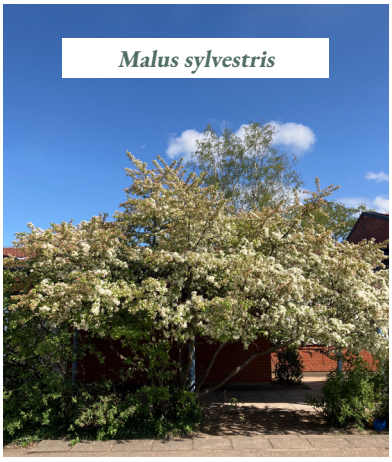
3. Where do authorities reside in connection with the BGS?

**Appendix 6:**
**Key tree species F-F6 school ground 12 May 2022**





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