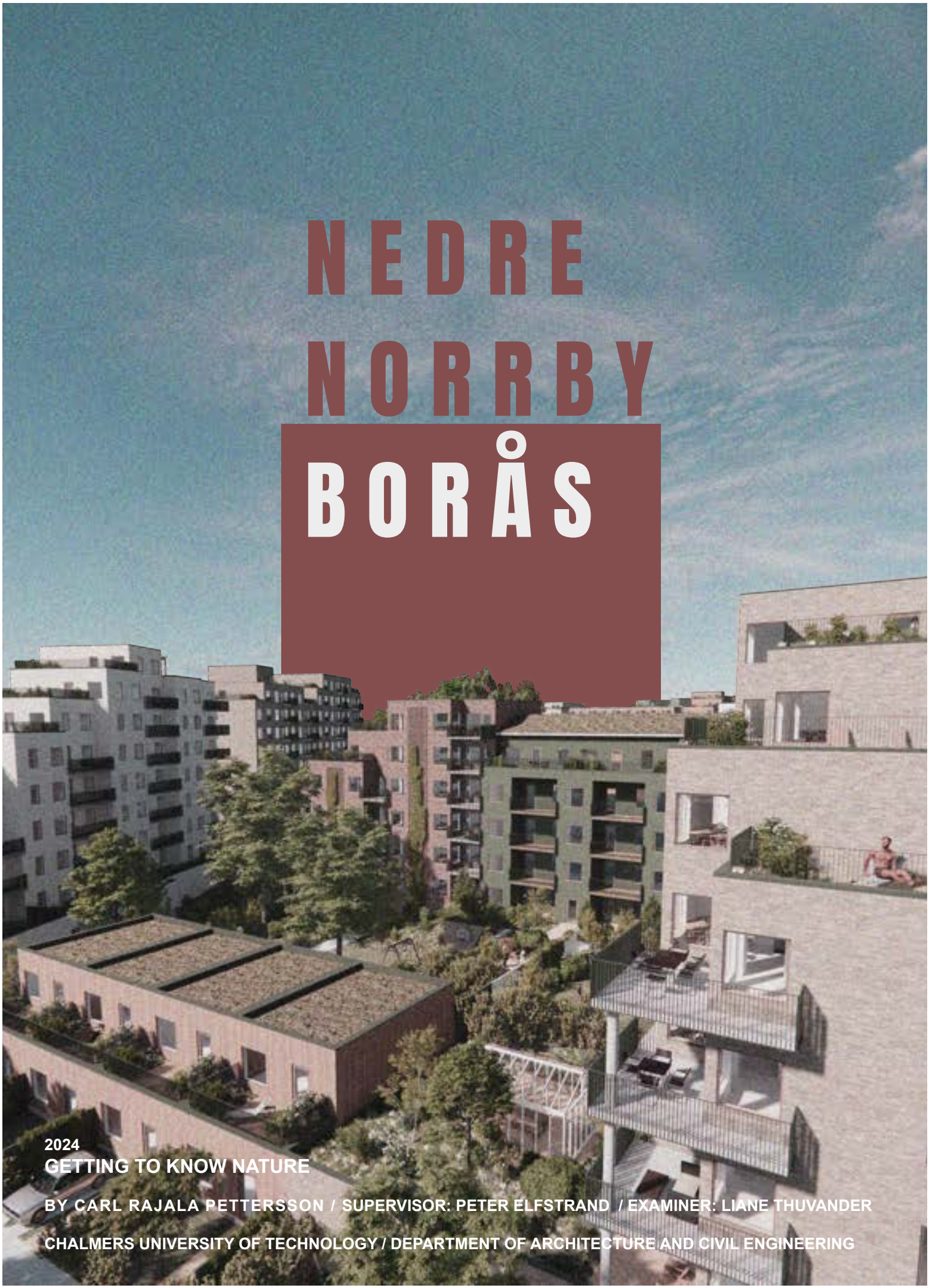

NEDRE NORRBY BORÅS

2024

GETTING TO KNOW NATURE

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Getting to know nature
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Architecture and Planning Beyond Sustainability
Building Design and Transformation for Sustainability

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ABSTRACT

The population of the world is growing. Above all, it is the cities that are growing. How we use land and water, plan and build determines whether we can preserve and develop the capacity of ecosystems to deliver ecosystem services. Global warming, animal extinctions and the poisoning of nature are fundamentally about disruption of natural process or ecosystems. By planning for ecosystem services in human society, the need for technical interventions can also be reduced.

Living environments with close and integrated greenery are essential for our health and well-being. Spending time in green environments helps to lower blood pressure, heart rate and stress levels. Despite the numerous advantages humans gain from nature, contemporary lifestyles have led to a detachment from the natural world, with a substantial increase in indoor activities.

Ecosystem services can be valued in different ways. Biotope area factor is a type of semi-quantitative valuation of ecosystem services. This simplification of the work with ecosystem services has the potential to be a support for architects to evaluate design proposals from an ecosystem services perspective.

The purpose of this thesis is to explore ways for sustainable expansions within cities, i.e. densification, in relation to urban ecosystem services and residential qualities. The thesis focuses on three ecosystem services: biodiversity, water purification and regulation and pollination.

From the theory on residential qualities related to the outdoor environment and biophilic design, evaluation tools are developed. Together with the biotope area factor tool, explorations on urban components and typologies are carried out. The results of the explorations, in combination with knowledge from previous research, forms design strategies. The design strategies are put into practice in a design proposal for the densification of Nedre Norrby in Borås. The design task does also address other challenges in the city.

The thesis concludes that the transformation of Nedre Norrby could contribute to ecosystem services in Borås and at the same time create many residential qualities in a new mixed content and high density neighbourhood.

Keywords: Ecosystem services, residential qualities, biotope area factor, densification

CARL RAJALA PETTERSSON

THESIS MOTIVATION

When searching for a topic for the master's thesis, the idea of looking at architecture's relation to nature was top of mind. I find this relationship intriguing and have always been interested in the potential and the qualities that can be achieved by working with integration of vegetation and landscape in the built environment.

To give this interest a context, I chose a site in the Swedish city of Borås. I grew up on the outskirts of Borås and view the city as my hometown. Borås has gone through a transformation from a textile industrial city to a service based economy. The city is partly still establishing a new identity. The transformation of Nedre Norrby can be one piece in the puzzle in this work. The city plans to transform the current brownfield into a new urban mixed-use area.

There are several sustainability challenges in relation to cities. The challenge of combining an urban dense city with functioning ecosystems is highly relevant. Creating good living environments for people in these dense cities is an equally important challenge.

To study how Nedre Norrby can combine urban density with functioning ecosystems and residential qualities is an interesting task. Borås Stad has ambitious plans of improving the conditions for biodiversity and ecosystem services with a new linear park throughout the city passing by Nedre Norrby. This together with Borås Stad's visions of strengthening identity forms an interesting and relevant challenge for architecture.

STUDENT BACKGROUND

2019-2022
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STUDIOS

2022
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2023
+ ARK626 Transformation projects and environmental care

2023
+ ACE580 Sustainable transformation of a derelict industrial building

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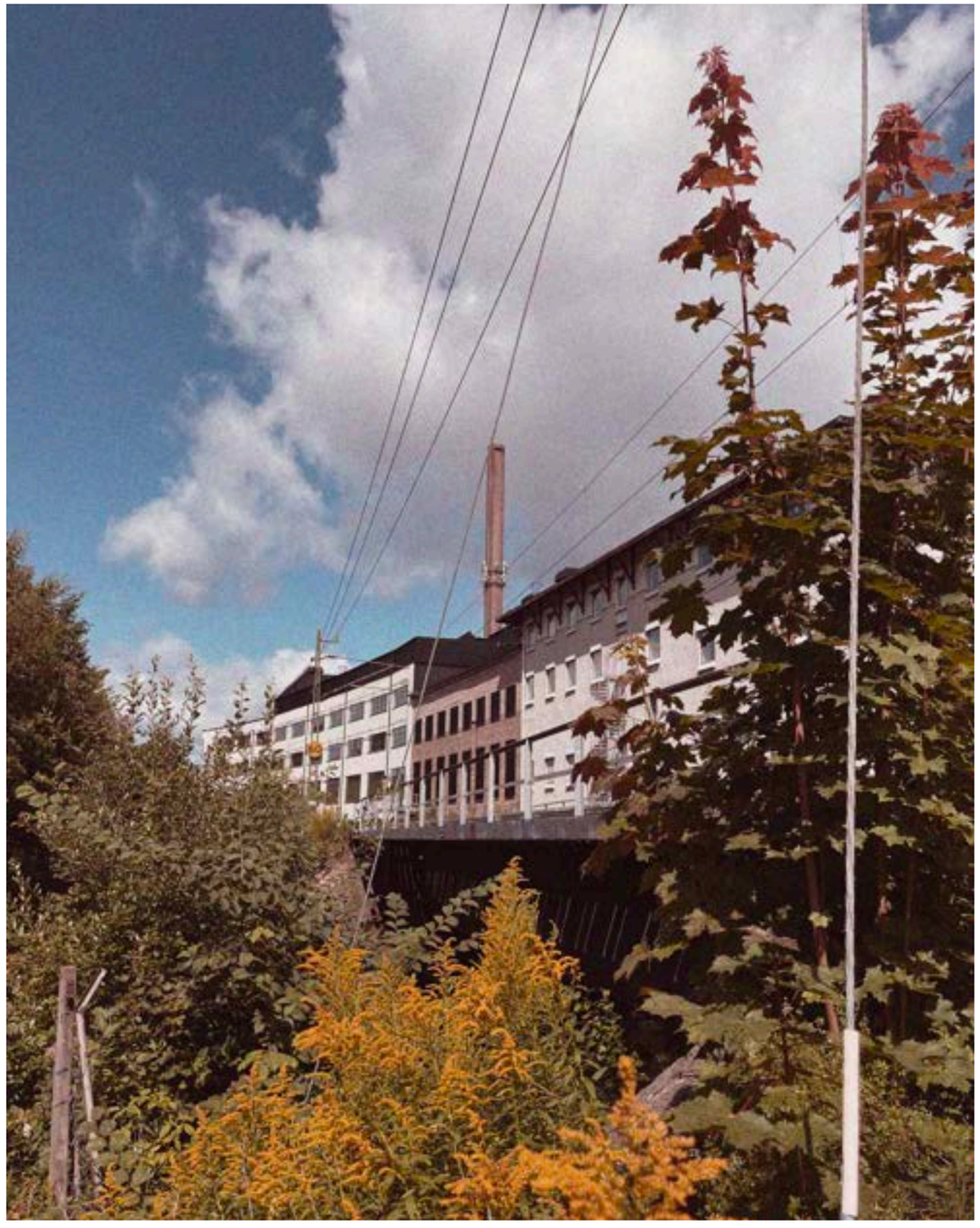
Unless otherwise stated, pictures, diagrams or illustrations are made by the author.



1 INTRODUCTION

BACKGROUND

NATURE AND HUMANS

There are multiple definitions of the word *nature*. Broadly speaking, the word nature is used to describe something that is not man-made (Ducarme & Couvet, 2020). In other words, the word nature refers to things like plants, animals, landscapes, lakes and seas. There is a lot of research showing that people feel good when they are in, what we describe, as natural environments or interact with objects that are considered part of the natural world (Kellert, 2018). The concept of biophilia aims to describe this relation. Biophilia refers to humans' inherent inclination to connect with other living beings, like plants and animals. Essentially, it suggests that humans naturally seek proximity to nature. This instinctive urge might stem from our extensive evolutionary history, during which we spent more or less all of the time (over 99%) in close association with nature. Biophilia theory argues that this world shaped us, and therefore our body is most suited to face these types of environments. Elements of this environment, like plants, water, sunlight, weather are therefore familiar to us. More recent created things like plastic or concrete are therefore seen as artificial because our body haven't faced these elements during most of our evolution (Kellert, 2018).

Despite the numerous advantages humans gain from nature, contemporary lifestyles have led to a detachment from the natural world, with a substantial increase in indoor activities (Kellert & Calabrese, 2015). Research suggests that humans spend as much as 90% of their lives indoors. This disconnection is particularly seen in developed and heavily urbanized countries, where the disconnection to nature is evident. This separation from the natural environment can adversely affect humans, as it removes us from the positive impacts of nature. Consequently, we experience decreased connection with nature and a decreased sense of obligation to preserve it (Kellert & Calabrese, 2015).

For the enlightenment philosopher Rousseau, nature is the state of the happy time that precedes civilization (NE, 2024a). The idea of a separation between human civilization and nature appears to have arose parallel with the industrialisation in the 19th and 20th centuries (Britannica, 2009). The technological developments changed humans' interactions with 'nature'. This view also forms the basis for the critique of civilization expressed in the 20th century debate on nature and climate. This view relates to the idea of nature as an environment in the form of plants, animals, landforms etc. that hasn't been affected by man, i.e. free from human impacts (NE, 2024a). This approach has gained a strong hold in Western culture (Harrisson, 2022). This view is quite narrow, and would exclude most of the 'nature' people face in their everyday life, like parks and gardens. Ecologists, however, dismiss this world view and argues that humans are part of nature just like all other living things (Dalrymple, 2022). Whether or not we see humans as part of nature is thought to have an impact on our willingness to protect plants and other living species (Schultz, 2002).

ECOSYSTEMS

During the Anthropocene Age, humans have been a significant factor in changing the Earth's geology, climate and ecosystems (NE, 2024b). Global warming, animal extinctions and the poisoning of nature are fundamentally about disruption of natural process or *ecosystems* (UNDP, 2024). In addition to the moral and emotional aspects of the changes of nature that human activitity causes, disruption of ecosystems is about destroying conditions for human survival. Production of food and raw materials, access to freshwater and oxygen, are dependent on the processes of ecosystems (UNDP, 2024). The term *ecosystem services* aims to describe these services that are produced by ecosystems (Boverket, 2020a). How we use land and water, plan and build determines whether we can preserve and develop the capacity of ecosystems to deliver ecosystem services. By planning for ecosystem services in human society, the need for technical interventions to solve, for example, water regulation and purification and regulation of pests and harmful plants, can be reduced (Boverket, 2020a).

Fig 1. Trees as backdrop outside my living room window.

In the UN's Agenda *2030 Goals for global sustainable development*, the protection and restoration of ecosystems in water and on land are defined in the14th goal and the15th goal (UNDP, 2024).

Summarizing, nature fulfill several functions for humans. Both as a backdrop in our living enviroment, contributing to our well-being, but also as parts of ecosystems that maintain vital ecosystem processes for humans. In this thesis, nature or elements of nature, has two purposes. The aim is to both use nature in relation to architecture to create sustainable ecosystems and ecosystem services, and to use nature to create sustainable living environments for humans, that benefit health and well being. Therefore, the idea of nature presented in biophilia is the basis for what nature implies in this thesis, i.e. environments or objects that through evolution are "natural" for humans.

GROWING CITIES

The population of the world and Sweden is growing. Above all, it is the cities that are growing. Cities act as magnets offering a range of jobs, education, experiences and culture (Boverket, 2019a). The trend of growing cities places demands on a sustainable development of them (Persson & Smith, 2014). Today's urban development takes place both through expansion of the city and through densification (Persson & Smith, 2014). The phenomenon of geographically expanding cities are often referred to as urban sprawl (Rafferty, 2009). The expansion is often characterized by low-density residential housing, single-use zoning and increased reliance on cars for transportation. Urban sprawl has been connected to increased energy use, pollution, and traffic congestion and a decline in distinctiveness of communities. By the increased physical and environmental "footprints" of metropolitan areas, the phenomenon leads to the destruction of wildlife habitat and to the fragmentation of remaining natural areas (Rafferty, 2024). The advantages of dense cities are that infrastructure can be used more efficient. It enables clustering for education and innovation, trade can be concentrated and meeting places can be increased (Boverket, 2016). The struggles of dense cities are to accommodate enough public spaces, such as green spaces, school yards and sports facilities, needed by the high concentration of people. The pressure on the few green spaces available causes damage on the little nature existing (Boverket, 2023). There is also a risk that inhabitants almost completely lack connection to green spaces (Persson & Smith, 2014). Achieving sufficient sun and daylight for inhabitants and avoiding turbulent wind situations are other challenges (Boverket, 2023b).

Fig 2. Dense city scape in Dhaka (Wikimedia Commons, 2023).

RELATION OUTDOORS AND RESIDENCE

The need and demand of nature in people's lives makes it interesting to focus on how these relate to the place people spend most of their time: at home. Access to greenery is an important part of a home (Boverket, 2019b). Green outdoor environments can also contribute with qualities to the home's indoor environment through the design of the interface between inside and outside of the dwelling (Boverket, 2024). Depending on what type and placement of nature or green environments there are in the city, the city's ability to produce ecosystem services and to create quality living environments for the residents are effected. A vegetated roof can provide important ecosystem services but may not provide the need for visual presence of nature from the resident's perspective.

If we are to build sustainable cities, the design of the physical environment needs to consider ecosystem services and residential qualities. In relation to the pressure of growing population in cities, this is a critical challenge for architects.

BORÅS / NEDRE NORRBY

As Sweden in general, the city of Borås is also expected to grow in the coming decades (Borås Stad, 2018). Borås Stad* aims for the city to consist of a dense, cohesive and mixed-use built environment and to grow primarily by densifying the city (Borås Stad, 2018).

Nedre Norrby is an area in the centre of the city that is planned to be transformed from a brownfield to a mixed-use neighbourhood, with dwelling, office spaces and smaller businesses (Borås Stad, 2024). The area is located between the city centre and the neighbourhood Norrby. Norrby was originally a working class neighbourhood and parts of the city's textile industry originated here (Ahlgren, 2023). The district changed shape completely in the 1960s when most of the buildings were demolished in a so-called urban renewal and replaced by today's high-rise buildings (Ahlgren, 2023). Norrby is today classified by the Swedish police as an area characterised by poor socio-economic conditions and organised crime (särskilt utsatt område) (Polisen, 2017). Previously, there were several industrial buildings on the Nedre Norrby site from the heyday of the textile industry at the turn of the last century. These were demolished in the 1970s in the time when majority of the textile industries relocated to low-wage countries, during the so-called Teko-crisis. Since then, the area has been an empty space in the centre of Borås (Borås, 2024).

The site has a central and strategic location by the railway station, but is cut off by several barriers in the city today, such as the railway and roads. The empty

** In this thesis, Borås Stad refers to the governor body of Borås, the municipality of Borås.*

Fig 3. Urban sprawl on the outskirts of Colorado Springs (Wikimedia Commons, 2008).

Nedre Norrby plot are also described as contributing to a physical, social, and mental distance between Norrby and the city center (Borås Stad, 2024). The plans for the area aim both to create space for new residents and businesses in the city as well as to have a connecting effect on Norrby in relation to the city centre. Transformation of the site has been planned for a long time but has not been possible due to plans for a new railway between Borås and Gothenburg. The new railway will possibly require land for a larger station area by Borås Central station. The Nedre Norrby site has so far been reserved for this purpose.

BROWNFIELD

Unprogrammed areas, i.e. areas without an explicit function, such as the plots at Nedre Norrby, become a void in the urban plan. These so-called brownfields or ruderal land are therefore often of interest to transform in order to contribute to the city's growth (Schéele, 2016). This is also the case in Borås. However, from an ecosystem and biodiversity perspective, brownfields fulfill significant functions (Persson & Smith, 2014). These types of soils are typically lacking in nutrients, which is uncommon in today's cities. They also feature exposed areas of sand and gravel. These environments are shaped by previous groundworks and building activities, as well as damage from vehicles. This combination, alongside the poor nutrient levels in the soil, prevents a thicker turf from growing. Because of this, ruderal soils can provide a habitat for unique species, primarily heat-loving plants and insects, typically found in rare habitats like ravines, riverbanks, nutrient-poor grasslands, and sandy plains. For example, surveys in Malmö, Sweden, revealed that ruderal environments hosted a greater variety of butterfly species compared to parks (Persson & Smith, 2014). This should therefore be kept in mind when developing these plots. Even if these areas appear meaningless in the city, they provide functions for ecosystems.

When the Nedre Norrby site is proposed to be developed, it is therefore relevant to consider how these values are not lost, in order to make the transformation as sustainable as possible. Which ecosystem services can be preserved and which ecosystem services can be created? How can the site benefit biodiversity?

The city of Borås aims to strengthen ecosystem services and biodiversity in the transformation of Nedre Norrby (Borås Stad, 2024). The report "Biologisk mångfald i Borås stad" (Biodiversity in the City of Borås) lists the ecosystem services that Borås Stad intends to focus on in planning. Biodiversity and pollination are particularly highlighted. This thesis will focus on these ecosystem services, as well as water purification and regulation, which also is mentioned in the report as an ecosystem service in focus. Water purification and regulation was also pointed out in my conversations with Borås Stad as an ecosystem service the city intended to actively work with (M. Lund, personal communication, February 19 2024).

WORKING WITH ECOSYSTEMS SERVICES

Ecosystem services can be valued in different ways. Biotope area factor is a type of semi-quantitative valuation of ecosystem services. The tool measure ecosystem services within a certain area, to value the green and blue qualities that are achieved in urban planning. The aim for the calculation model is creating qualitative values using a quantitative formula (Boverket, 2020b). This simplification of the work with ecosystem services has the potential to be a support for architects to evaluate design proposals from an ecosystem services perspective. The biotope area factor can help in the ambition to build dense urban structures, but at the same time plan for important ecosystem services (Boverket, 2020b).

Borås Stad has tested using the biotope area factor tool in some projects, but has not yet implemented it as a tool that must be used in land allocations for example, something that other municipalities have as a requirement. In talks with Borås Stad, several reasons were emphasised as to why there may be disadvantages in using the biotope area factor fool. For example, it can lead to projects being satisfied with meeting the required level of biotope area factor and not optimising the project's capacity to contribute ecosystem services. But the city is still interested in testing the tool (M. Lund, personal communication, February 19 2024).

In this thesis, the biotope area factor tool will be used to evaluate conditions for ecosystem services in architectural designs to make a transformation proposal for the Nedre Norrby site.

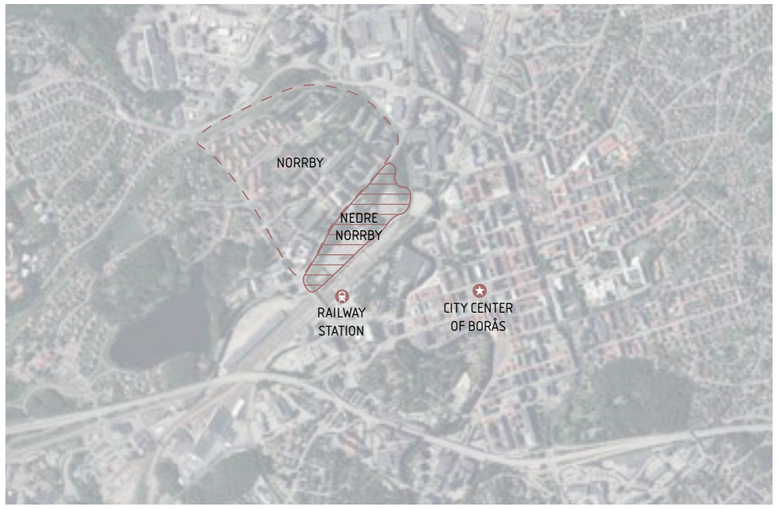


Fig 4. Location of Norrby and Nedre Norrby site in relation to the city centre of Borås. Illustration based on ortophoto from Lantmäteriet (2024).

Fig 5. Nedre Norrby today.

THESIS QUESTION

AIM

The purpose of this thesis is to explore ways for densification within cities, in relation to urban ecosystem services and residential qualities. The thesis studies residential qualities in relation to nature and outdoor areas in all different parts of the living environment. From inside the dwelling, the private outdoor space, the shared yard and the public spaces. By exploring this, a basis for a design proposal for the Nedre Norrby area can be proposed.

The design proposal in this thesis should meet Borås Stad's overall vision for the transformation of Nedre Norrby. The transformation is supposed to create new connections over the railway to link the Norrby area to the city center and fit new mixed-use development, in total 75 000 sqm GFA in the area.

THESIS QUESTION

How can ecosystem services and residential qualities work together in the transformation of the Nedre Norrby site in Borås?

GOALS

+ Make a design proposal for Nedre Norrby...

...matching Borås Stad's vision of developing an urban high density mixed-use neighbourhood.

...that combines the selected ecosystem services with residential qualities, i.e. taking advantage of the green and blue environment created by ecosystem services, to improve the daily life of the residents of the neighborhood and the quality of their homes.

...achieving an higher biotope area factor-quota than the area has today.

+ Use, adapt and evaluate the biotope area factor tool to help find design strategies that benefit the selected ecosystem services in the project.

+ Develop evaluation parameters to assess residential qualities related to the outdoor environment to develop design strategies.

METHOD

This thesis approach can be divided into four steps: research for design, making and adapting evaluation tools, explorations of components and typologies and finally making a design proposal.

RESEARCH FOR DESIGN

Firstly, the theories on which the thesis is based, are described, i.e. research for design. These are theories behind ecosystems and the three ecosystem services in focus of this thesis, biodiversity, water regulation and purification and pollination, and theories on residential qualities related to the outdoor environment. Relevant reference projects are also presented.

Site analysis are made of the Nedre Norrby area and the site's current conditions with regard to ecosystem services, use and links to the city. For this, the Borås Stad's documentation for the work to produce a structure outline for the western city centre are used and complemented by site visits. Reports on green connections and ecosystem services in the city of Borås and the biotope area factor tool are used to identify ecosystem services in the area today.

EVALUATION TOOLS

To explore different design solutions, evaluation tools are needed. In this thesis, the biotope area factor tool GYF 3.0 (Grönytefaktor för stadsdelar 3.0) are used to evaluate ecosystem services. The tool is free to use and so called open source. This means that the tool can be customized based on usage. In this thesis, the tool are adopted to focus only on biodiversity, water purification and regulation and pollination.

To simplify the calculations, different types of surfaces are defined and scored in regards of what ecosystem services they provide.

The theories on residential qualities are translated into a evaluation parameters to be able to evaluate designs from this perspective.

EXPLORATIONS

In order to investigate how the Nedre Norrby site can be designed to provide space for new and existing ecosystem services, while also benefitting residential qualities, various urban components and typologies are explored. The purpose for this is to see what the different elements and composition of them in the design means to ecosystem services and residential qualities.

COMPONENTS

First, components of the urban environment are explored. In this work, the urban components where ecosystem services can be generated have been divided into five categories: nature/park, yards, streets, green roofs and vertical vegetation. These components are scored with the biotope area factor tool. As a starting point for the exploration of the different components, project references have been used. These have either a focus on ecosystem services, residential qualities or is a local reference.

TYPOLOGIES

The exploration of the different components provides a basis for investigating how the composition of the different components affects ecosystem services and residential qualities. This composite exploration is based on investigating the application of four different building typologies on the Nedre Norrby site. The different typologies generate different footprints of buildings, amount of space for streets or yards, for example.

A characteristic dwelling for each typology is used for the exploration of residential qualities, with different types of interfaces to the outdoors and type of private outdoor spaces. The biotope area factor of the components calculated in the previous exploration is used to provide a biotope area factor on the composite exploration.

DESIGN

The results of the exploration of the components and typologies are summarized into design strategies that combine the ecosystem services with residential qualities, supported by strategies found in the literature in research for design. The strategies are adopted in a design proposal for the Nedre Norrby site, matching Borås Stad's visions.

The design proposal ranges from a masterplan for the site to an example of a dwelling unit, showcasing the relation between ecosystem services and residential qualities. The design proposal's conditions for the selected ecosystem services are evaluated using the biotope area factor.

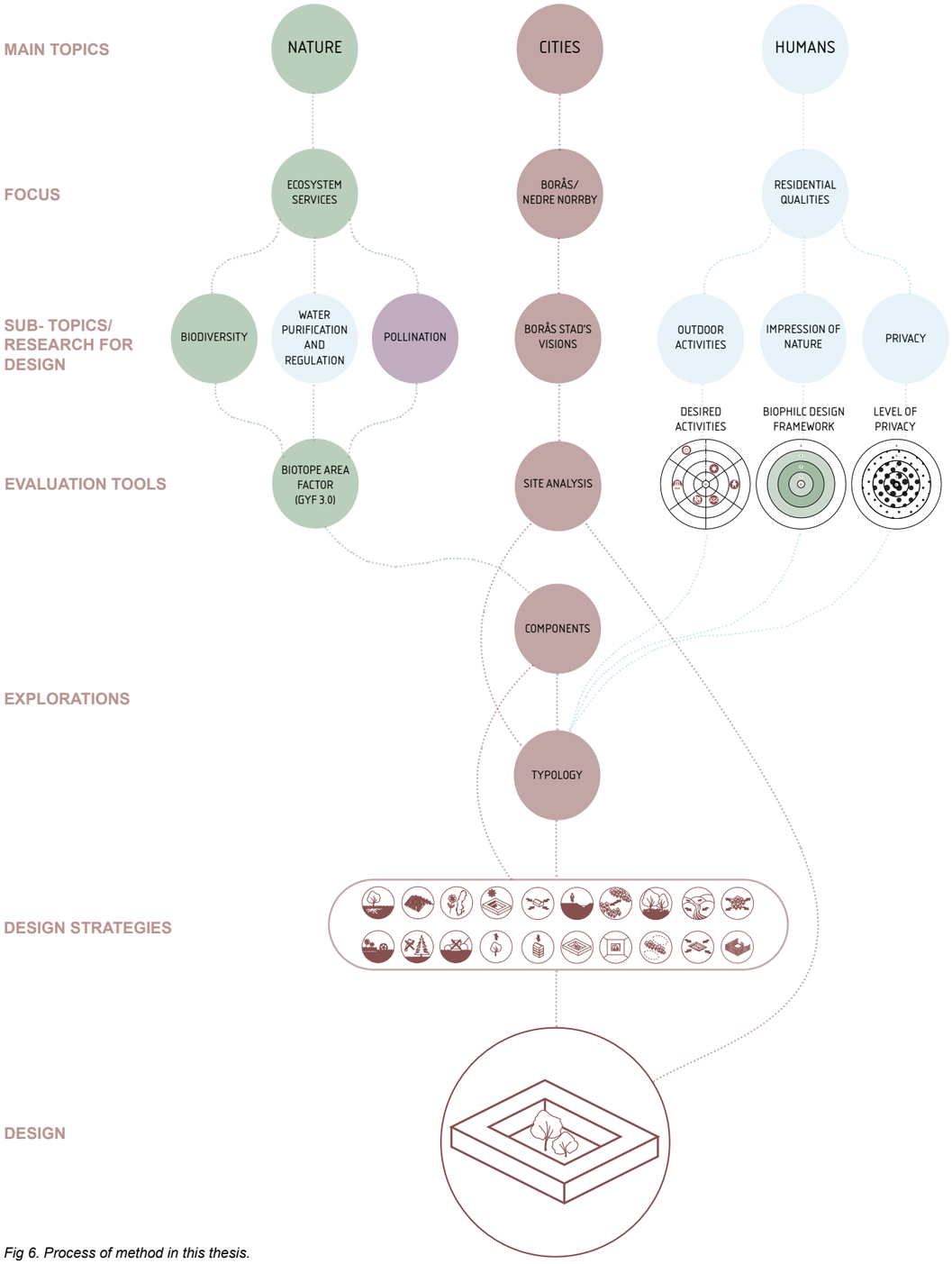


Fig 6. Process of method in this thesis.

DELIMITATIONS

In this work, the biotope area factor tool is a way to give an indication of which types of urban environments that are favourable for contributing with ecosystem services. However, understanding and planning ecosystems is very complex and this is therefore a very simplified analysis. The main purpose of the biotope area factor is to see if there are conditions for ecosystem services. This can make ecosystem services understandable from an architectural perspective. The weighting and scoring of experts in the biotope area factor tool makes it possible as an architect to compare different types of solutions. The key is having a consistent method to compare different solutions. From this, conclusions can be made on how the built environment can be planned to promote ecosystem services.

Inventorying and assessing ecosystem services requires expertise. In this project, I use the large-scale inventories conducted by Borås Stad together with examples from the GYF 3.0 manual, to get as accurate as possible. In some cases, areas have been assessed based on other literature or scoring in other biotope area factor tools. A detailed ecosystem service inventory by an expert has not been made on site within the framework of this thesis. In this regard, objects that score qualities in the GYF 3.0 biotope area factor tool, that requires expertise to identify, has been excluded.

As mentioned, this thesis focus especially on the ecosystem services biodiversity, water purification and regulation and pollination. It needs to be emphasised that in most cases, ecosystem services do not exist in isolation but are linked to other ecosystem processes whose benefits are therefore less visible, but not less valuable. When focusing on a few services in goal setting and design, as in this thesis, one needs to be aware that other processes are also involved and can influence the final outcome (Persson & Smith, 2014). Except from the ecosystem services studied in this thesis, other ecosystem services are also produced.

The biotope area factor tool has been adapted to calculate only biodiversity, water regulation and purification and pollination. The biotope area factor is therefore only adapted to the objectives defined in this project and cannot be compared with a biotope area factor calculated with GYF 3.0 in other projects.

The main purpose of this project is to investigate the interface between ecosystem services and residential qualities with a focus on how this affects the architecture. That is, the main focus will not be to report how some of the nature-based solutions should be organised exactly, with plant selection, etc., but to start from more principled solutions. Therefore, surfaces have been generalized and scored in the biotope area factor tool to make the work manageable as an architect.

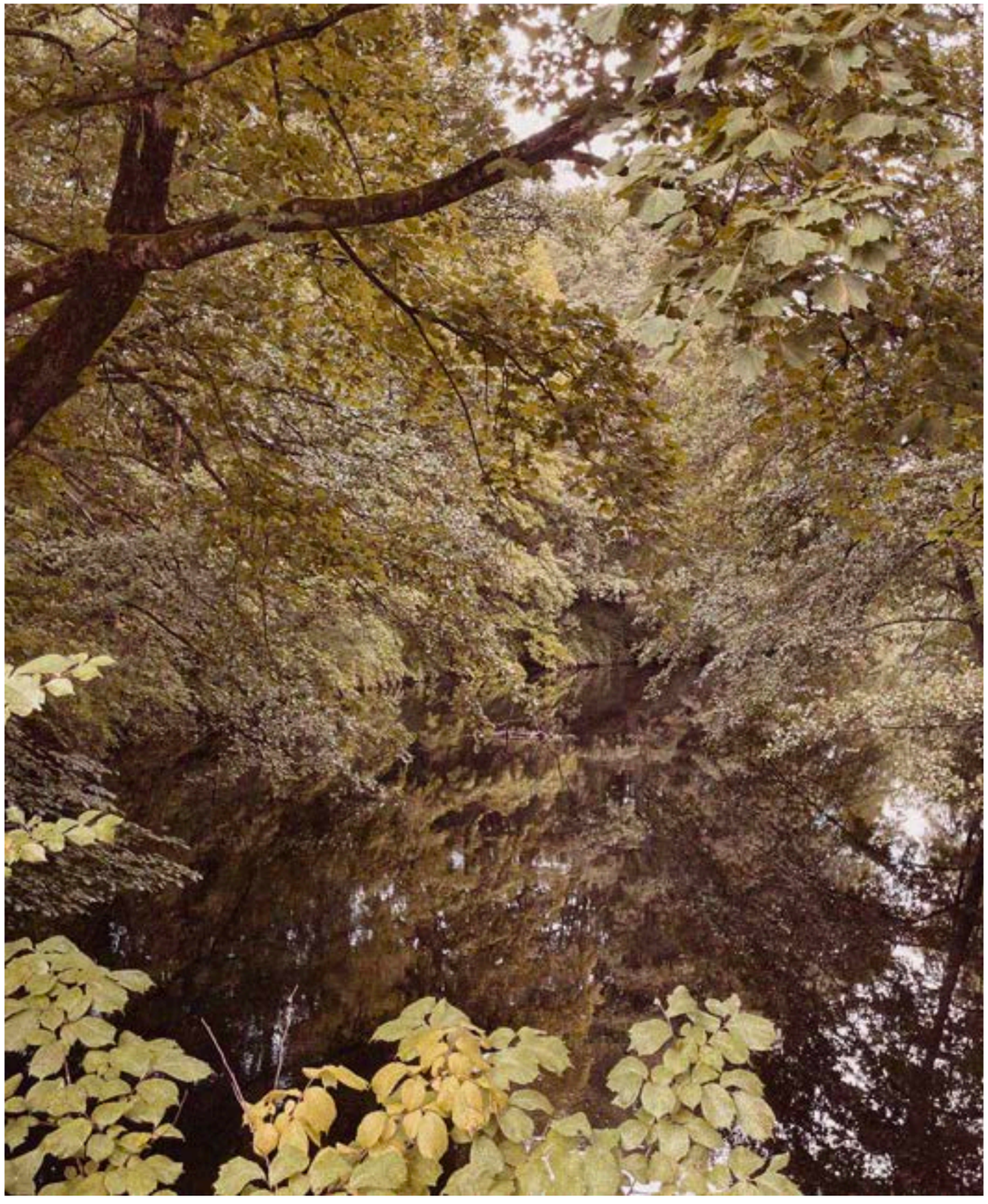
There are many aspects of what creates residential qualities. In this work, a selection has been made focusing on the qualities that are clearly linked to the outdoor environment. The work is set in a Swedish context and this also applies to residential qualities. In other countries, other qualities would probably have been emphasised.

The social functions of the outdoor environment are an important residential quality. Residential courtyards, streets and parks are places where we interact with our neighbours and fellow citizens. In order to limit the work in this thesis, the residential qualities of being able to socialise between households will not be in focus. However, being able to socialise within a household on private patios or courtyards is included in the residential qualities studied.

The design is also based on assumptions that soil remediation can be carried out and retain most of the existing greenery on the Nedre Norrby site.

The spatial impact of the new railway between Borås and Gothenburg have not yet been decided. In this thesis, the assumption is that the railway area does not need to be extended beyond today's Magasinsgatan.

The solution for protecting parks from dangerous goods routes has not been considered in this work. However, protection from dangerous goods routes has been considered for residential courtyards.



2 RESEARCH FOR DESIGN - THEORY

ECOSYSTEMS / ECOSYSTEM SERVICES

In a time of growing population and expanding cities, there is a need to explain human activities in relation to ecosystems and what type of impact we have on ecosystems.

ECOSYSTEMS AND ECOSYSTEM PROCESSES

The term ecosystem is used to describe how organisms, such as micro-organisms, plants and animals, interact in an environment and their interrelationships (Persson & Smith, 2014). These interactions are the basis for ecosystem processes. This generates a constant flow of both organic and non-organic material between the different parts of the system. The exchange of oxygen and carbon dioxide between the atmosphere and living organisms on land and in water, as well as the recharge of groundwater and the decomposition of organic matter, are examples of important ecosystem processes. The processes of an ecosystem are 'performed' by its organisms in combination with physical processes. The species present in an ecosystem have different characteristics. Therefore, these processes will depend on the characteristics of the particular organisms present in the system. Depending on how these species are affected, there are consequences for the whole ecosystem (Persson & Smith, 2014).

BIODIVERSITY

Biodiversity refers to a diverse composition of all living things. This variation exists at several levels; from genetic variation (genetic differences between individuals and populations of the same species), to variation between species and variation between biotopes (Persson & Smith, 2014). Ecosystem processes are produced by living organisms and some ecosystems can be maintained by a limited number of species. But biodiversity has a positive effect on the resilience of ecosystems (Naturvårdsverket, 2024b). Therefore, higher biodiversity usually leads to higher functional diversity, i.e. an ecosystem with a greater variety in how organisms influence and contribute to ecosystem processes (Persson & Smith, 2014).

ECOSYSTEM SERVICES

Ecosystem services is a concept that has emerged to define how humans are part of and what we benefit from ecosystems (Naturvårdsverket, 2024b). When we talk about ecosystem services, we regard humans as a part of nature that both utilizes and affects these services in various ways. Examples of an ecosystem services can be how forests contribute through ecosystem processes to carbon sequestration, pollination, food production, providing raw materials and bioenergy (Naturvårdsverket, 2024b). Working with ecosystem services is supported by international conventions, the EU's biodiversity strategy and nationally by the Swedish Government environmental objectives (Naturvårdsverket, 2024b). The UN Convention on Biological Diversity (CBD) is an important basis for work on ecosystem services. Ecosystem services are also linked to most of the global goals for sustainable development, Agenda 2030 (Naturvårdsverket, 2024b).

The UN Millennium Ecosystem Assessment (MEA) initiative published a report in 2005 that categorised ecosystem services into four main categories: supporting, regulating, provisioning and cultural (MEA, 2005). The categorisation made by the MEA initiative is the basis for the Swedish categorisation of ecosystem services made by the Swedish National Board of Housing, Building and Planning (Boverket), together with the Swedish Environmental Protection Agency (Naturvårdsverket) and the association C/O City (Ahlström Isacson et al., 2021). The Swedish categorisation will be used in this thesis.

There is some criticism of the concept of ecosystem services. The term refers to humans being provided with services that inhabitants can choose or not choose to 'consume' (Lisberg Jensen, 2010). This is not true, as ecosystem functions are not negotiable. Without them, the society first becomes increasingly vulnerable and then collapse. Ecosystem services are fundamental for the existence for humans (Lisberg Jensen, 2010). Cities are, and have always been, dependent on ecosystem services (C/O City et al., 2022).

URBAN ECOSYSTEM SERVICES

Urban ecosystem services are the ecosystem services produced in urban ecosystems (C/O City, 2014). Increased urbanisation often results in the encroachment of natural environments and the reduction of green urban infrastructure, resulting in qualitative and quantitative reductions in urban greenery. This impairs the conditions for the production of urban ecosystem services such as noise and air pollution reduction and climate regulation. Another effect of reduced vegetation and increased impermeable surfaces in cities is the increased negative impact on storm water flows that negatively affect both humans and animals.

Urban ecosystem services are interdependent with ecosystems outside the city. Cities are part of the global system and depend on ecosystem services that originate far beyond the city's boundaries. Efforts to promote conditions for urban ecosystem services often focus on the ecosystem services that

are consumed locally in the city (C/O City, 2014). This will also be the focus of this work. By planning for ecosystem services to solve societal challenges, the need for technical interventions can be reduced. This is also called *nature-based solutions* (Naturvårdsverket, 2024b).

In 2013, Region of Stockholm published a report stating that the regulatory function of ecosystem services often proved to be superior to corresponding technical solutions (C/O City et al., 2022). With climate changes, cities are severely affected by floods and heatwaves, with very high costs to society. Investments that strengthen the green structure therefore provide significant socio-economic values (C/O City et al., 2022). An example of how effective ecosystem services can be is the Catskill Mountains forest area, 100 miles northwest of New York City. The forest has long provided the city with clean drinking water, but logging and development had gradually polluted the water (Boverket, 2020b). In the mid-1990s, the city was faced with a choice: build a $9 billion water treatment plant or restore and protect the Catskill Mountains. The latter option was chosen, resulting in a final bill of $2 billion. Allowing nature itself to purify drinking water became a major financial saving, while safeguarding the biological and cultural values of the area today (Boverket, 2020b).

As mentioned, this thesis will focus especially on the ecosystem services of water purification and regulation (regulating), pollination (regulating) and biodiversity (supporting). Biodiversity is not an ecosystem service by definition, but is a necessity for the long-term capacity of ecosystems to deliver ecosystem services (Naturvårdsverket, 2024b). Nevertheless, biodiversity is included among the 22 ecosystem services listed in the Swedish classification, categorised as a supporting ecosystem service. This is because in spatial planning, it can be advantageous to work with and map biodiversity together with the supporting ecosystem services, as they have a strong link (C/O City et al., 2022). In this way, the links between biodiversity and ecosystem services become clear and communicable (C/O City et al., 2022).

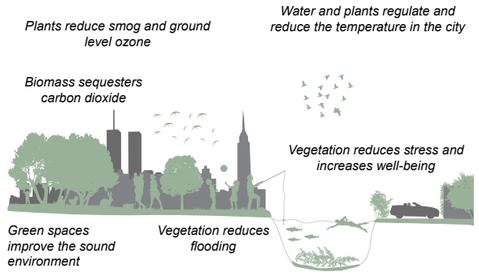


Fig 7. Examples of urban ecosystem services. Illustration is based on C/O City et al. (2022).

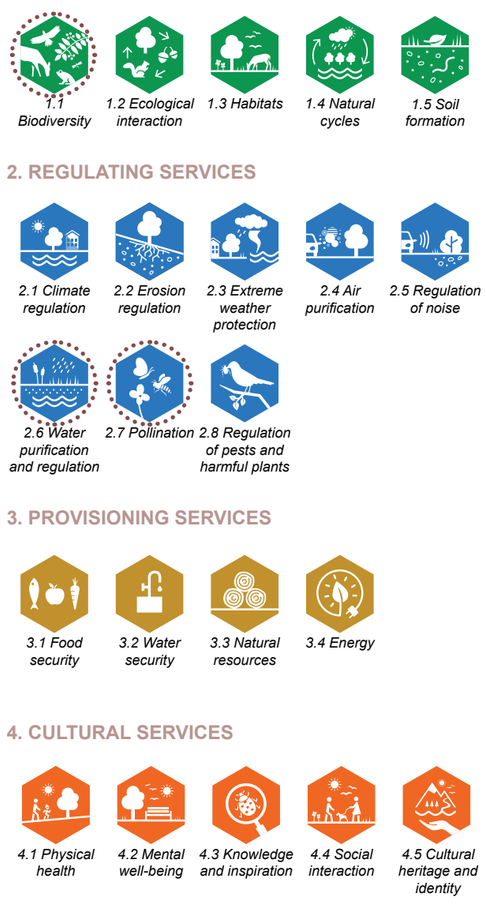


Fig 8. Symbols of different ecosystem services, made by Boverket & The New Division (2024). The ecosystems in focus in this thesis are marked with a circle.

BIODIVERSITY

Increasing and managing biodiversity and associated ecosystem services requires an understanding of the processes that influence species populations to exist (Persson & Smith, 2014). Biodiversity in an area depend on both the type of the local environment and the type of landscape in which it is located. Locally, for example, soil, latitude, microclimate and type of management can influence diversity, while this effect can be modified by regional factors, such as how well connected the area is to similar areas in its surroundings (so-called connectivity) and the quality of the surrounding environment (so-called matrix) (Persson & Smith, 2014).

Urban green spaces are generally small and isolated from other green spaces (fragmented) and environmentally uniform (low diversity) (Campbell et al., 2008). This leads to lower biodiversity compared to larger, well-connected and diverse green spaces. Urban green spaces are also characterized by a high degree of disturbance, which favours disturbance-resistant and often already common species (Campbell et al., 2008).

A basic recipe for promoting urban biodiversity is to create areas of low management intensity that vary in appearance and content, and are connected to each other (Persson & Smith, 2014). For example, dead tree trunks and tall, tufting grasses are important habitats for many organisms (Persson & Smith, 2014).

Another simple and inexpensive way to promote biodiversity is to allow the spontaneous establishment of vegetation, i.e. to let plants grow freely, without being planned by humans (Kühn, 2006). Vegetation establishes itself spontaneously almost everywhere in the city; on abandoned land, in plantations, cracks in the asphalt or on walls. This vegetation is well adapted to the environment and requires no maintenance to persist, it is both ‘free’ and ‘sustainable’. But often, it is considered a weed and is removed, even though it often poses no real problem. To avoid the perception of poor management, which is often the reason why this vegetation is removed, smaller interventions can be made to signal management. For example, cutting paths through taller vegetation or keeping entrances and edges of areas clearly managed or adding clearly human-controlled objects such as art installations (Kühn, 2006).

Depending on the type of biodiversity you want to achieve, different species can be favoured (Persson & Smith, 2014). Some species are well suited to the special conditions of a city with hardened environments and a dry and warm climate. In addition, much of the species composition of cities is made up of exotic (alien) species that have been deliberately planted or have spread spontaneously. This means that urban environments are often different from natural environments outside the city. Urban biodiversity is often more similar to each other than to surrounding natural areas, even across and between continents. To recreate or strengthen local ecosystems, it is advisable to focus on local species that have a natural place in the ecosystem. Exotic introduced species risk upsetting the balance of local ecosystems and destroying the conditions for many other organisms in the ecosystem (Persson & Smith, 2014).

WATER PURIFICATION AND REGULATION

When it rains in nature, water flow is slowed down by vegetation, collected in the porous soil before it slowly moves into streams and wetlands and finally reaches lakes and oceans (Boverket, 2021). Some of the water is also absorbed by plants and soil, where it can transpire and evaporate into the atmosphere. In cities, on the other hand, impermeable surfaces lead to faster and larger storm water flows with more pollutants, which are managed through often limited storm water pipes. By designing solutions based on nature's own way of managing storm water, we can reduce flood risks in cities (Boverket, 2021).

Natural solutions used for water regulation include ditches, rain beds and ponds. Green roofs also have a delaying effect and reduce storm water runoff. Depending on the vegetation and type of roof, green roofing can reduce storm water runoff by 40 to 90% over the year (Boverket, 2021). By reducing the amount of impermeable ground, water can naturally move into the ground. Storm water retention and flood risk reduction is largely a matter of the elevation of the area, i.e. where the water flows when it rains. In the event of heavy rainfall, the water does not have time to infiltrate, so there needs to be flooding areas for larger volumes (Boverket, 2019c). Filtration can also be achieved by using nature-based solutions. Bioinfiltration is the umbrella term for natural infiltration and can achieve a high degree of separation of particle-bound pollutants. Rain beds, for example, purify a large part of added zinc, PAH and oil, as well as about 65% of phosphorus and copper (VA-guiden, 2024a).

POLLINATION

Pollination is an important ecosystem service (Persson, 2012). Pollination is mainly carried out by insects such as different types of bees, as well as flower flies and butterflies, that contribute but to a smaller extent. From a sustainability perspective, and with documented declines in pollinating insects in agriculture landscapes in mind, measures to benefit these are an important step towards securing functioning ecosystem services in urban environments. There is a great potential for a rich fauna of pollinators in urban environments. Allotments and gardens are already favourable environments, but by expanding and adapting green spaces, creating flowering environments and lowering the intensity of management, to create more natural habitats, the conditions for pollinators can be improved. The choice of plants should be adapted to the insects' need for a diversity of native species and a long flowering season (Persson, 2012). Increasing the number of pollinators in the city requires both nesting sites (for bumblebees and bees) and larval host plants/habitats (for flower flies and butterflies), as well as suitable nectar and pollen plants. In general, natural habitats typical of the region favour the wild insect fauna, as the native fauna is adapted to the regional environment. Pollinators benefit from low-intensity management of green spaces where environments are allowed to become more or less permanent (Persson, 2012).

BIOTOPE AREA FACTOR

Ecosystem services can be valued in different ways. The Swedish Environmental Protection Agency (Naturvårdsverket) presents the following ways: words (qualitative valuation), physical unit, such as the amount of raw materials produced in a given period or the number of visits to a recreational area (quantitative valuation), scoring scale (semi-quantitative valuation) and monetary valuation (Naturvårdsverket, 2015).

Biotope area factor is a type of semi-quantitative valuation. In brief, it involves dividing an area into different types of areas, each with a certain value (Emanuelsson, 2014). The area are then multiplied by their sub-values and summed up. This sum, the so-called eco-efficient area, is then divided by the total area to obtain a measure of the amount or quality of green and blue elements. This figure is called the biotope area factor. Target values can be set for the biotope area factor in projects. For example, new developments within a certain area have to reach a certain biotope area factor (Emanuelsson, 2014).

There are several versions of the tool. The Swedish adaptations of the tool originates from Berlin's tool Biotopflächenfaktor developed in the 1990s (Emanuelsson, 2014). In Sweden, Malmö was the pioneer when Västra Hamnen was transformed into a residential area in connection with the 2001 housing fair, Bo01. This was the first time the tool was used in Sweden. Different Swedish municipalities have their adoption of the tool. Malmö, Stockholm, Gothenburg and others have their versions (Emanuelsson, 2014).

ABOUT C/O CITY AND GYF 3.0

C/O City is a membership association where several actors from the urban planning sector in Sweden want to make the benefits of urban ecosystem services visible. Current members include municipalities, consultancies and universities. The organisation provides advice and has produced manuals and tools for working with ecosystem services (C/O City, 2020). The organisation collaborates with the Swedish National Board of Housing Building and Planning (Boverket) and the Swedish Environmental Protection Agency (Naturvårdsverket). Even though Borås Stad is not a member of C/O City, they have used the biotope area factor tool developed by C/O City, called QGYF (QGIS based-Grönytefaktor). In this thesis, another version of the QGYF-tool will be used, called GYF 3.0 (Grönytefaktor för stadsdelar 3.0). QGYF and GYF 3.0 are the same kind of biotope area factor tool, with the same way of calculating ecosystem services (C/O City, 2023a). The difference is that QGYF is a plugin in QGIS that allows the calculation of areas and biotope area factor to be calculated directly in the program. GYF is an Excel-based calculation form where areas need to be calculated separately (C/O City, 2023a). In this thesis, the computer program SketchUp will be used for the design work and also for calculating surfaces. Therefore, the GYF version is better suited for this work. The tool is free to use and so called open source. This means that the tool can be customized based on how it will be used. In this thesis, the tool will be adopted to focus only on biodiversity, water purification and regulation and pollination.

WORKING PROCESS RECOMMENDATIONS

C/O City have guides for how to work with ecosystem services and the GYF 3.0 tool. In a brief they recommend to work in the following way:

- Define goals for the use of biotope area factor.
- Collect inventory data of the site conditions. Ecosystem services are usually dependent on a landscape context. Therefore, a larger area than the project site, is usually needed to be considered.
- Calculate a biotope area factor for the site today.
- Calculate biotope area factors for different development scenarios.
- Make decisions according to the defined goals

(C/O City, 2023b)

Preferably multiple expertise, like urban planners, ecologists, environmental strategists should be involved in the work with the biotope area factor (C/O City, 2023b). The tool can be used on several scale level, like for a neighbourhood or a building block (C/O City, 2023b).

HOW TO CALCULATE THE BIOTOPE AREA FACTOR

The GYF 3.0 tool handles a selection of ecosystem services such as biodiversity, noise reduction, stormwater management, microclimate regulation, pollination, recreation and health. Furthermore, each group of ecosystem services contains qualities such as created objects or surfaces that favour biodiversity, noise barriers, vegetation absorbing water, leaf shade, pollinator nodes and walking paths in nature.

The tool is based on identifying green and blue areas in an area and then calculate the ecosystem services they provide. The ecosystem services are divided into qualities such as biodiversity (Q1-Q10), noise reduction (Q11-Q17), stormwater management (Q18-Q23), microclimate regulation (Q24-Q28), pollination (Q29-Q31) and recreation and health (Q32-Q43).

The selection of ecosystem services and qualities is made with regard to both the intended scale of the tool and to represent the most important ecosystem services for the urban environment. Since the tool is adapted to the urban environment, it is therefore not as applicable to, for example, agricultural land, which provides many supporting ecosystem services (C/O City et al., 2022).

These are the following steps of calculating the biotope area factor:

1. Calculation of the area of the site. Calculation of the area is usually done in CAD or GIS. In this project SkecthUp will be used.

2. Calculation of the different areas for green and blue areas. This is done by dividing the site into areas defined in the GYF 3.0-tool.

3. Calculation of the area for the different qualities. This is done based on the previously defined areas. The area is multiplied by a weighting factor in the calculation template. The weighting factor is based on its effectiveness in delivering ecosystem services. For example, more points are given if the green and blue spaces are multifunctional, i.e. if they fulfill several qualities at the same time. In this thesis, the tool will be adopted to only calculate biotope area factor for the ecosystem services biodiversity, water regulation and purification and pollination.

4. The score for green and blue spaces is added to the score obtained for the different qualities. This is divided by the area of the site to give the value of the biotope ara factor. Eco-efficient area refers to all green and blue areas that contribute to the ecosystem services counted by the tool. The score calculation is anchored in current research and is reviewed at regular intervals.

$$\text{GYF-QUOTA} = \frac{\text{ECO EFFICENT SURFACE}}{\text{TOTAL AREA OF THE SITE}}$$

ECO EFFICENT SURFACE = S+Qx

S = Total area of green or blue surfaces
Q = Total area of all qualities
x = Weighting factor

Fig 9. Calculation of GYF-Quota. Based on illustration by C/O City et al. (2022).

Living environments with close and integrated greenery are essential for our health and well-being (Boverket, 2019b). Spending time in green environments helps to lower blood pressure, heart rate and stress levels. It also helps to strengthen short-term memory and prevent dementia. Green spaces are furthermore found to encourage physical activity, which in turn benefits multiple health aspects like reducing obesity, diabetes and mental health problems (Boverket, 2019b).

ZONING

This work aims to study residential qualities in relation to the outdoor environment, i.e. its surroundings. A dwelling faces the outdoor space of the garden, street or nature with various forms of interfaces. Interfaces in the form of balconies, windows, porches and patios are important to the residents' relationship with the place and can bring qualities to the home (Forshed & Nylander, 2003). In order to investigate and understand how the surroundings and the dwelling interact, the dwelling will be studied on several scales and from different functions. One way of understanding and illustrating the relationship between the home and the surrounding outdoor environment is through the principle model developed by the Swedish University of Agricultural Sciences (SLU) . The model defines five different zones in this connection, gradually going from private to public. Four of these zones have contact with the outdoor environment (Bengtsson et al., 2018). The model has been developed from a healthcare perspective for the rehabilitation of patients to illustrate how the values of the different zones overlap and are interrelated.

The model defines five zones, four of which have contact with nature and the outdoor environment:

+ Zone 0 - Zone without contact with the outdoor environment
+ Zone 1 - Contact with the outdoor environment from inside the building, for example through windows
+ Zone 2 - Contact with the outdoor environment in the transition zone between inside and outside, for example in conservatories, on balconies, patios and terraces
+ Zone 3 - Contact with yards and gardens, directly adjacent to the building
+ Zone 4 - Contact with the external environment, i.e. outside the building and its immediate surroundings.

(Bengtsson et al., 2018)

This model illustrates that connections between the zones can be both physical and visual. This affect the possibilities and ways to interact and gain residential qualities.

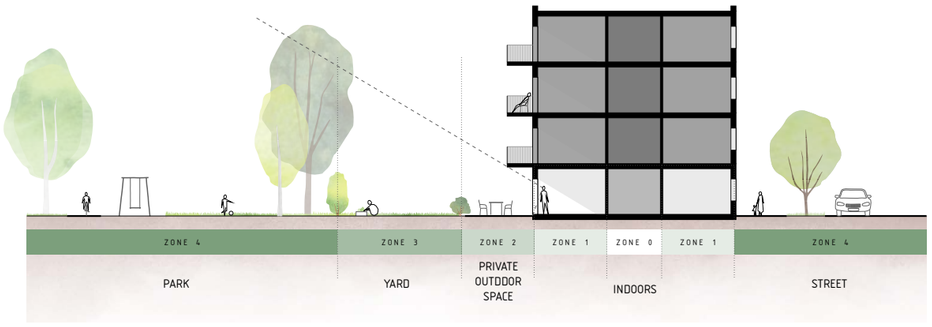


Fig 10. Example of a home's relation to the outdoor, according to the different zones by Bengtsson et al. (2018). The illustration also shows outlook from inside the dwelling.

FUNCTIONS

The outdoor environment fulfils several functions for the dwelling. To understand the basic functions of the outdoor environment, we can look at how the residential courtyard functions and what activities it provides for the resident. Eva Kristenssons booklet from 2007, *Bostadsgården – vardagsrum, lekplats, mötesplats & utsikt* (The courtyard - living room, playground, meeting place & view), describes how the courtyard is important for the home with four categories of functions:

Outdoor area close to home
An outdoor area close to the home is linked to being able to carry out outdoor activities in direct connection to the home (Kristensson, 2007). It is similar to the use of a villa garden. Examples of desired activities include sunbathing, outdoor cooking, socializing with family and friends and gardening. Sun and light are deciding conditions in Sweden to create quality outdoor spaces and make them being used, especially during spring and fall. Also protection from wind or shaded areas are needed qualities outdoors.

Play area
The opportunity for children to play outdoors is important from both an educational and recreational perspective. Research shows that families with children are the ones who use the outdoor environment the most.

Meeting place
The yard is one of the most important meeting spots in the neighbourhood, either by planned or random meetings. Most people like to know their neighbours, it contributes to safety, well-being and identity. Most people prefer to be able to regulate the interactions with their neighbours to balance closeness and distance.

Views
The way the yard is positioned affects its relationship to the private dwelling. In some cases, the yard is clearly visible from the interior of the dwelling. It may also be positioned so that we pass it every day on our way in and out of the home. The role of the yard as a view is about what impressions of the yard we get, through our eyes. Eva Kristensson refers to landscape architect Ulla Berglund and sociologist Ulla Jergeby, who in many of their studies of the city's outdoor environments see that the view from the home is of great importance when choosing a home. Wide views, nature and greenery and being able to see people are appreciated qualities. Greenery is described as providing peace, creating a feeling of space and integrity.

(Kristensson, 2007)

These functions do not have to take place in a residential courtyard. Depending on the context of the dwelling, other parts of the dwelling or the local environment can replace the functions of the courtyard. In today's housing development, the trend is that larger private outdoor areas are being built, while shared yards seem to be smaller and smaller (Reiter, 2007). It is a well-known fact that if the residents have a balcony, terrace or private patio, these are used instead of the yard, if the activity allows it (Berglund & Jergeby, 1998). The reasons for residents to choose the private outdoor area over the shared yard are partly for convenience reasons, the contact to the indoors, and partly for privacy and freedom that allows the residents to do what they want without anyone having the right to intrude and interfere (Berglund & Jergeby, 1998). The same relation goes for the shared yard and a public park (Minuora, 2019). This highlights connections and privacy as a quality for housing.

PRIVACY

Whenever it comes to housing, privacy is a fundamental condition. In Ola Nylander and Kjell Forshed's book *Bostadens omätbara värden* (The Unmeasurable Values of Housing), the chapter on spatial organization describes the interaction between the outdoor and indoor environments of the home. They describe that privacy and territory are keystones in creating residential qualities (Forshed & Nylander, 2003). Being able to be private in one's home and in connected outdoor spaces, is of great importance. The clarity of the boundaries, for the private outdoor space or the shared outdoor space, creates awareness of the territory, as well as being able to mark one's territory. This is related to safety and security, natural parts of the concept of well-being. Three elements - ability to overview an area, clarity of what is public and what is private space, and moderate scale - are fundamental to a safe home (Forshed & Nylander, 2003). These principles are in line with the results presented by Eva Minoura in her book from 2019 *Bostadsgården - Territoriell arkitektur* (The Courtyard - Territorial Architecture). According to Minoura, the demarcation of a residential yard is an important factor for its use (Minoura, 2019). Yards that are clearly defined and perceived as private show more traces of use

and housing initiatives, in the form of plantings and toys, compared to less defined yards. Forecourts and semi-open courtyards are used less than other yards. This is due to the fact that it is unclear to both the resident and the public who is responsible or allowed to stay there (Minoura, 2019). The size of the yard is also related to the experience of privacy and the use of the yard (Granath & Nylander, 2023). Ola Nylander and Kaj Granath define in their guidebook for residential qualities that a good size of a yard is between 1 500 and 2 500 sqm of connected space. Per housing unit, the space should be at least 10 sqm to generate space for multiple types of outdoor activities and allow several activities to happen at same time without disturbing each other. To give the yard a private feeling, it shouldn't be too big or shared by too many dwellings, maximum 200 (Granath & Nylander, 2023).

EXPERIENCE OF NATURE

As stated by Eva Kristensson, impressions of nature is an important residential quality. To deeper understand how nature and vegetation in the outdoor environment can affect humans in the living environment in a positive way, the theories on biophilia and biophilic design can be used. Biophilia describes humans' inherent ability to feel love for all living things and benefit from natural environments (Kellert, S. and Calabrese, E. 2015).

BIOPHILIA

The idea of biophilia originates from an evolutionary perspective on humans and was formulated by Edward O. Wilson in the book Biophilia (1984). Throughout more than 99% of our history, we biologically developed in relation to natural and not human engineered environments (Kellert, S. and Calabrese, E. 2015). Therefore, the human body, mind and senses are adapted to a natural environment and is why our body has a positive physical reaction to nature. Humans' ability to physically and psychologically react positively to an environment does not necessarily correlate to how natural an environment is, i.e. how little influenced by humans it is, but how the environment is experienced in relation to humans' biological conditions to react positively to environments.

The idea of biophilic design is to translate what makes human react positive to 'nature' into design guidelines, and define what experience and attributes of nature that benefit humans health and well being.

BIOPHILIC DESIGN

There are multiple frameworks for biophilic design. The pioneer within the subject, Stephen Kellert, created a framework of 25 attributes for biophilic design (Kellert, S. and Calabrese, E. 2015). Kellert divides his framework into three types of experiences. Direct experiences of nature implies actual contact with elements of nature, such as light, plants or water. Indirect experiences of nature refers to contact with images or patterns of nature, for example natural materials like wood or ornamentation inspired by shapes in nature. Finally, experiences of space and place aim to represent the spatial characteristics of the natural environment that have developed human health and well-being. Examples include prospect and refuge, organized complexity, mobility and wayfinding (Kellert, S. and Calabrese, E. 2015).

To understand what makes an environment nature-like, all these attributes should be evaluated. To limit the work of this thesis and make it manageable to evaluate what environments are perceived as nature-like, a selection of the most defining attributes have been made (attributes marked in **bold** below). These are primarily attributes relating to direct experiences of nature.

Kellert's 25 attributes of biophilic design:

Direct experiences of nature
1. Light, 2. Air, 3. Water, 4. Plants, 5. Animals**, 6. Natural landscapes and ecosystems, 7. Weather, 8. Views**, 9. Fire

Indirect experiences of nature
10. Images, 11. Materials, 12. Texture, 13. Colour, 14. Shapes & forms, 15. Information richness, 16. Change, age and the patina of time, 17. Natural geometries, 18. Simulated natural light & air, 19. Biomimicry

Experiences of space and place
20. Prospect & refuge, **21. Organized complexity,** 22. Mobility, 23. Transitional Spaces, 24. Place, 25. Integrating parts to create wholes
(Kellert & Calabrese, 2015)

All the biophilic design attributes are experienced through different human senses. The most dominant sense is the visual sense (Kellert, S. and Calabrese, E. 2015). Visual presence of these attributes makes us react positively physically and mentally. Multisensory experiences strengthen this reaction (Kellert, S. and Calabrese, E. 2015). Also closeness to the attributes of biophilic design has an impact (McLennan, 2018). Distance and height make the experiences of the attributes abstract and reduce the positive impact (McLennan, 2018). To summarize: the more attributes experienced, and the more senses activated by this, the stronger the experience of nature is.

PEOPLE ARE DIFFERENT

How humans experience nature is different. Recent studies by researchers at Gothenburg University and SLU show that both heredity and environment affect people's relation to nature (Gunnarsson, 2023). In a Japanese study, people were allowed to walk in a forest and in a city while their heart rate was measured. It showed that the positive feelings during the forest walk increased for 65% of the people. That states that far from everyone experienced nature as positive. The relationship with nature during childhood is indicated as an important factor for the relationship one has with nature. Nature can also mean different things to different people. Some people appreciate a park with lawns and planted trees, while others prefer a wilder nature. It is therefore not possible to believe that one type of nature, or that wilder nature suits everyone. The researchers believe that this variation is also determined by both heredity and environment (Gunnarsson, 2023). However, studies show that people generally appreciate having a variety of outdoor environments and species around them and that more 'organic and natural' environments are more valued than those that are heavily managed (Persson & Smith, 2014).

SUMMARY

Residential qualities include many things. I have, within the framework of this thesis, divided the residential qualities into three categories, to simplify the use of the concept of residential qualities in relation to the outdoor environment. I have summarized the theory used for this work as follows:

OUTDOOR ACTIVITIES

The category "Outdoor activities" are mainly based on activities that Eva Kristensson highlights under the headings *Outdoor area close to home* and *Play area*. This includes activities such as playing, cooking outdoors, socialising and sunbathing.

PRIVACY

Privacy is fundamental when talking about residential qualities and is emphasised by Kristensson, Minoura and Nylander. The possibility to choose to be private is a basic requirement for a living environment. The degree of privacy of balconies, patios and residential courtyards has a major impact on whether these spaces are utilised and how they are used. Visibility, definition of boundaries and size of shared spaces affect whether the spaces are perceived as private or not.

IMPRESSION OF NATURE

Eva Kristensson emphasises views of the outdoor environment as a fundamental quality. Biophilia highlights the importance of experiencing nature in everyday life.

Experiencing nature-like environments has a positive impact on human well-being and health. Whether an environment is perceived as natural or not depends on, among other things, the presence of natural elements such as light, air, water, plants, animals, natural landscapes and ecosystems, weather and views, and how these are composed in relation to each other, i.e. the degree of variation.

PROJECT REFERENCES

Several references have been used in the various parts of the thesis, both in explorations and for the design proposal. Here are the ones that have had the most influence on my work.

Fig 11. 79&Park (Wikimedia Commons, 2019).

79&PARK

LOCATION: Stockholm
ARCHITECTS: BIG Group
CONSTRUCTION YEAR: 2018
REFERENCE USED FOR: Exploration and design

Through its terraced form, 79&Park creates the conditions for a large number of roof top terraces. The building combines high density development with an enclosed private residential courtyard, which through the building's rising roof silhouette can be sufficiently sunlit as the building is lowered towards the south (Hernández, 2024).

Fig 12. Bosco Verticale (Wikipedia contributors, 2024).

BOSCO VERTICALE

LOCATION: Milano
ARCHITECTS: Boeri Studio
CONSTRUCTION YEAR: 2014
REFERENCE USED FOR: Exploration

Bosco Verticale was named the world's most beautiful skyscraper in 2015 (Boeri Studio, 2015), and the way it uses plants as an element of its design is inspiring to many. No matter where in the towers you live, you have access to a lush terrace. But the buildings also has a big negative impact on resource management, as it requires a solid frame to support all the plants and soil, and it uses a lot of water for the plants in Italy's hot climate (Last, 2021). This also makes it very expensive to live in the building (Last, 2021). The thing that inspires me the most with this building is the fact that no matter if you live on the ground floor or the 10th floor, you can still see a tree or a bush outside your window.

Fig 13. Brf Viva.

BRF VIVA

LOCATION: Gothenburg
ARCHITECTS: Malmström Edström Arkitekter
CONSTRUCTION YEAR: 2019
REFERENCE USED FOR: Exploration

The Brf Viva project had a strong focus on ecosystem services and how the existing ecosystem services on the site before construction could be replaced/supplemented during construction (Riksbyggen, 2017). The project applied the strategies of creating green connectivity, and the use of local species to promote ecosystem services. They did not use the biotope factor tool in the project, but evaluated strategies through a so-called ecosystem service analysis.

The project also had a strong focus on innovative housing solutions with flexible floor plans, car pooling and communal spaces (Luco, 2024). The focus was to promote community among residents through use of common spaces (Riksbyggen, 2017).

Brf Viva showcases how buildings can be placed in a diffucult terrain and how the surrounding landscape can be integrated and approached.

Fig 15. Bo01 (Wikimedia Commons, 2014).

BO01

LOCATION: Malmö
ARCHITECTS: Klas Tham
CONSTRUCTION YEAR: 2001
REFERENCE USED FOR: Exploration and design

Bo01 was the first project in Sweden to use a biotope area factor tool and had a strong focus on ecosystem services (Emanuelsson, 2014). The project combines several different types of housing, with both apartments, terraced houses and villas in a dense urban area. The way of mixing different types of buildings has been an inspiration to me in this thesis, as this is a desirable feature in the transformation of Nedre Norrby. Bo01 has several inspiring solutions for integrating ecosystem services. These include the use of an "open" storm water system with streams, channels and ponds through the neighbourhood.

Fig 16. Övre Johanneberg.

ÖVRE JOHANNEBERG

LOCATION: Gothenburg
ARCHITECTS: Uno Åhren
CONSTRUCTION YEAR: 1937
REFERENCE USED FOR: Exploration

During the time I have been working on this thesis, I have lived in Övre Johanneberg. During my walks to and from school, the surroundings have had an inspiring impact on me.

Övre Johanneberg is true to the ideals of functionalism. The area manages to combine a large number of homes, vibrant city life with shops and restaurants and generous residential courtyards that flow together and create a coherent park.

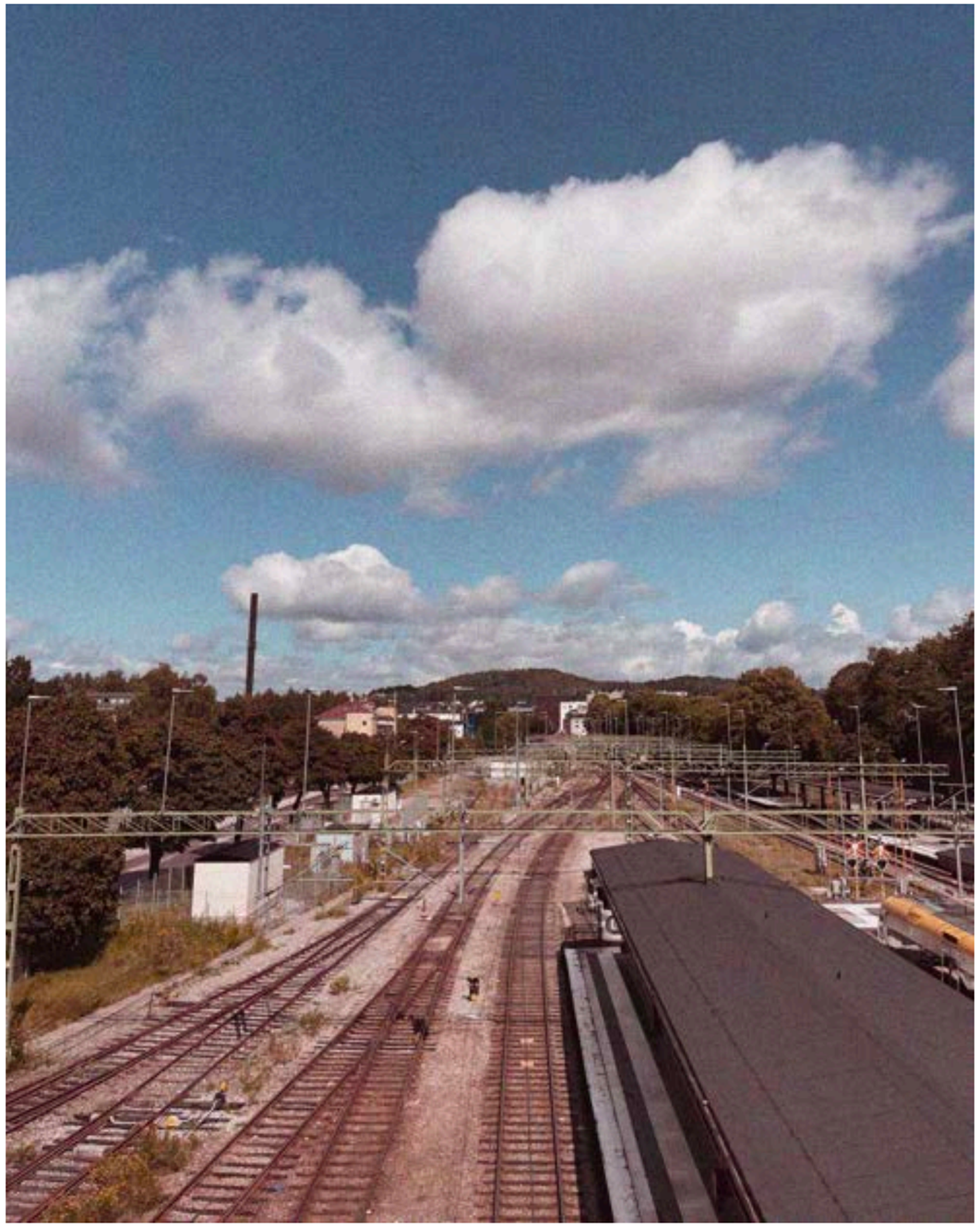
This park-like environment has a positive impact on me when I get to walk in it and see things like big trees, flowers and wildlife. However, I also see shortcomings in the outdoor environment. Although I feel that the space is used to some extent by residents, this space could be even more utilised, also by me. The lack of boundaries, privacy and clear programming of the space creates an uncertainty about who the space belongs to, who is allowed to be there and what you are allowed to do.

Fig 17. High line (Wikimedia Commons, 2010).

HIGH LINE

LOCATION: New York City
ARCHITECTS: James Corner Field Operations/
Diller Scofidio + Renfro
CONSTRUCTION YEAR: 2009
REFERENCE USED FOR: Design

The high line has become world-famous as a green corridor above the streets of New York. This elevated railway was closed down and wild plants were able to grow freely for decades (The High Line, 2024). Ideas of transforming the railway into a public park grew in the end of the 1990s and the project was realised in 2009. The project is a good example of how the meeting between the urban environment and wild nature can be handled.



3 CONTEXT AND SITE ANALYSIS

CONTEXT

BORÅS

Borås is the second largest city in the region of Västra Götaland, and Sweden's thirteenth largest municipality in terms of population (Borås stad, 2023a). The city is characterised by its history dominated by textile industry. It was this industry that made the city grow strongly from the end of the 19th century. In the 1960s, the Teko crisis hit and resulted in many factories closing down and a shrinking population in the city. Several industrial buildings have been demolished, but the cityscape in Borås is still partly characterised by industrial buildings (Borås stad, 2023a).

Today, Borås has a more mixed economic structure. The city is still an important hub in what remains of the Swedish textile industry. Several clothing company´s head offices are located in the city and also the Swedish School of Textiles (Borås stad, 2023a).

NORRBY

Norrby is a relatively small but central neighbourhood in Borås. There are 4,000 residents in Norrby and more than half of them are foreign-born or foreign citizens (Ahlgren, 2023). Most of the properties are owned by the municipal housing company Bostäder i Borås and over 80% of the 1,200 apartments are rental apartments (Ahlgren, 2023). Since 2017, Norrby has been classified by the police as an area characterised by poor socio-economic conditions and organised crime (särskilt utsatt område) (Polisen, 2017).

Despite its central location in the city, Norrby is segregated from the city due to several barriers, such as the Coast-to-coast railway, Norrby Långgata and the river Viskan.

Nedre Norrby is the name of the area south-east of Norrby Långgata (see figure 19). The industries Dalhems Väveri, Norrby Snickeri and parts of Borås Wäferi, were previously located on the site, but were demolished from the 1970s to the turn of the millennium. The area is located in the centre of Borås along the railway line, opposite to Borås Central Station.

The majority of the area is today used as a parking lot and contains about 650 parking spaces. Four buildings remain on the site. The oldest remaining building is Dalhems Väveri, a former office building that is now used as a mosque (seen in picture 1 in figure 20). However, the Muslim community is looking for new premises, which means that the current one is expected to be empty in the near future. The other three buildings are located in the centre of the area. Along Magasinsgatan there is ICA's old warehouse and office building (seen in picture 2 in figure 20), which is now called the labour movement's house and houses premises for the Swedish Left Party, LO and other trade unions. Up towards Norrby Långgata is an office and business building containing several different companies (seen in picture 3 and 4 in figure 20).

On the other side of Norrby Tvärgata, Borås Stad has organised a graffiti wall on one of the old stone walls from Borås Wäferi's former buildings (seen in picture 5 in figure 20).

114 592
people are living in Borås.

Fig 18. Borås' location in Sweden.

Fig 19. Above, map of the Nedre Norrby site today (map in background from Lantmäteriet, 2024) and Borås Wäferi and old Norrby in the 1930's (below). The old picture mainly shows former Borås Wävferi at Verkmästaren 3 (Murberg, 2016).

Fig 20. 1. Former Dalhems väveri, currently used as a mosque, 2. The labour movement´s house, 3. Office premises at Norrby Tvärgata, 4. Mural in Nedre Norrby, 5. The graffitti wall, 6. Norrby Långgata.

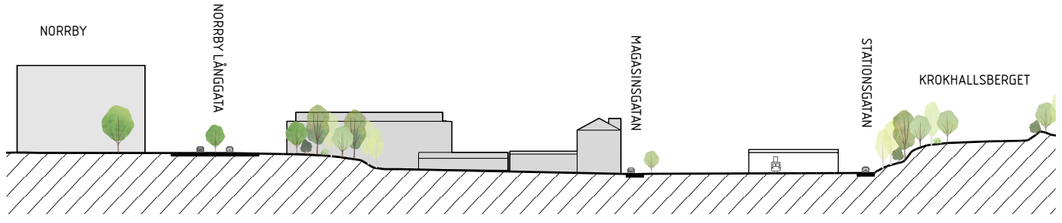


Fig 21. Section A-A of Nedre Norrby today. Scale 1:2000.

PROGRAM FOR NEDRE NORRBY

A so called “structure outline” (strukturskiss) has been developed as a tool for Borås Stad to work in the level between the master plan for the city and the detailed development plan. The purpose is to create consensus between committees, administrations and companies in the early stages of the urban development process (Borås stad, 2024).

The Nedre Norrby site is part of the structure outline for the western area of the city centre. The background to this work is to have a common direction for urban development along the railway tracks and the station area in order to meet the Swedish Transport Administration’s (Trafikverket) plans for a new railway between Borås and Gothenburg (Borås stad, 2024). No decision has yet been taken on the exact route of the railway or when it will be built. The aim is to start constructions between the years 2025-2027 (Borås stad, 2023b).

Several major urban development projects near the station area are already underway, such as the Viskaholm block and the transformation of the Pulsen area (see figure 22). The aim with the structure outline is to give an holistic overview of the area and show how Borås city centre can expand to the west, across the river Viskan (Borås stad, 2024). The objective is to create an enlarged and well connected Borås. The new railway will also bring Gothenburg and the towns along the railway line closer (Borås stad, 2024). Previously there have been plans for the transformation of the Nedre Norrby site. In 2014, architects from Snøhetta and Vandkunsten made a proposal for the site (F. Hjelm, personal communication, January 24, 2024).

In the structure outline and in a meeting with Borås Stad (S. Aneljung Warren & F. Lorentzon, personal communication, February 9, 2024), ambitions to have a varied architecture on the Nedre Norrby site are expressed, in contrast to the current parts of Norrby built in the 1960s (Borås stad, 2024). New and existing greenery are also considered as important components for the aesthetics in the transformation (Borås stad, 2024).

VISKAN PARK

Viskan Park is intended to be a 5 km long park path through Borås, from north to south (Borås Stad, 2021). The park is intended to run partly parallel to the Viskan river as a green twin. The purpose of the park is to link Borås’s different neighbourhoods, make it easier to move through the city, connect and secure green spaces as the city becomes denser, and create public meeting places. The construction of the park is intended to be done in stages in the upcoming decades (Borås Stad, 2021). Viskan park is intended to cross Nedre Norrby along Norrby tvärgata and continue over the railway towards the city centre via a new bridge featuring vegetation.

VISIONS

The design proposal in this thesis aims to meet the visions in Borås Stad’s stucture outline. I have summarized the main visions of the structure outline regarding the Nedre Norrby site into five parts:

1. Create new connections over the railway to link Norrby with the city.
Solution in structure outline:
- Two bridges: one at the station and one for Viskans park at Norrby Tvärgata (marked as 1 and 2 in figure 22).
- Move Norrbyleden down to Magasinsgatan to reduce the number of barriers in the area (marked as 3 and 4 in figure 22).

2. Create a safe and active city life on undeveloped and transformed areas.
Solution not formulated in the structure outline.

3. Bridges and buildings that create landmarks should resemble the character and identity of Borås.
Solution not formulated in the structure outline.

4. New parks on Nedre Norrby
Solution in structure outline:
- New park along Viskan at the nothern end of the Nedre Norrby site (marked as 5 in figure 22).
- New park along Norrby Långata (marked as 6 in figure 22).
- Viskan park passes thorugh Nedre Norrby over a new bridge along Norrby Tvärgata (marked as 2 in figure 22).

5. Include a variety of housing, but preferably more larger apartments, as this is generally lacking in Norrby today.
Solution not formulated in the structure outline.

THE VISION IN NUMBERS

- Accommodate 75000 sqm of GFA on the site, of which 80% is residential (700 homes) and 20% commercial premises (Exploitation rate: about 2).
- 300-600 public parking spaces on the site.
- 7 car parks per 1000 sqm GFA for residents/ workers.
- 25 bicycle parking spaces per 1000 sqm of GFA.

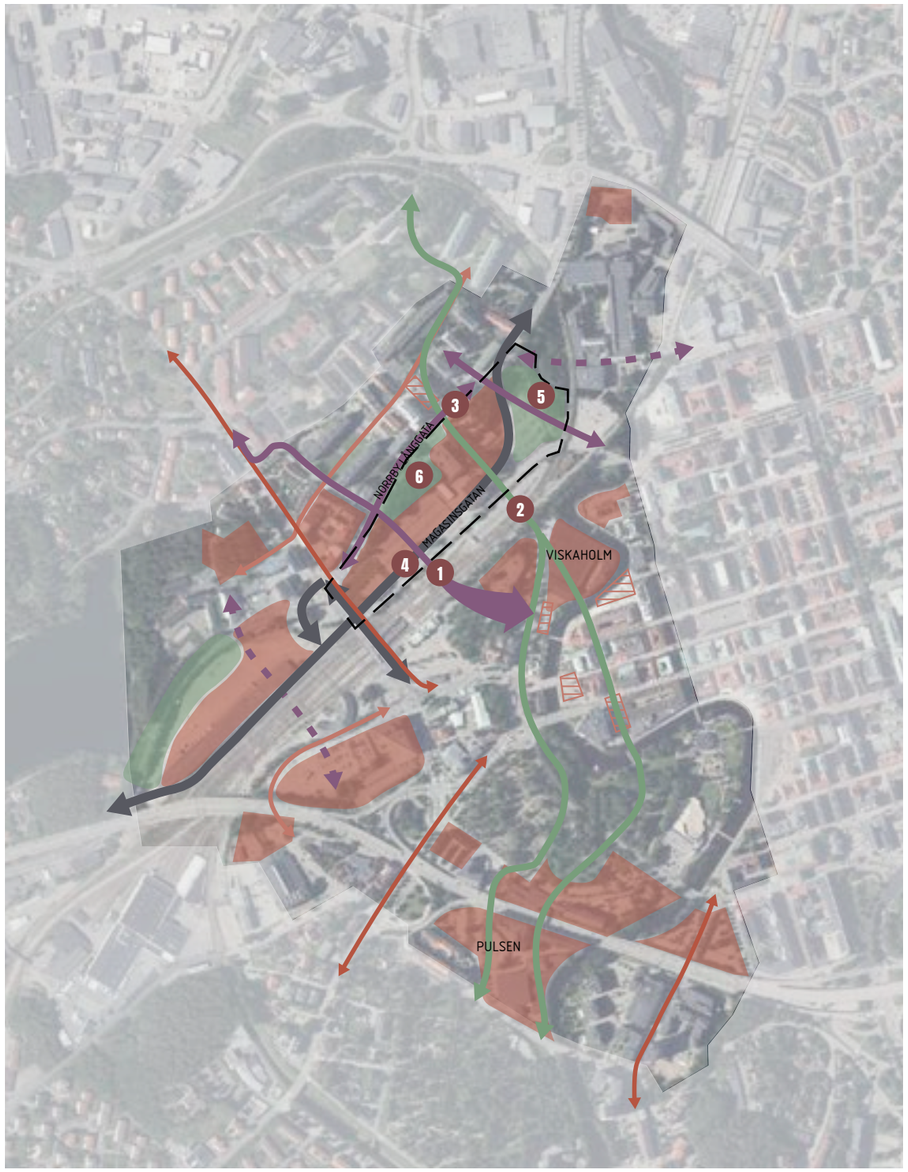


Fig 22. Borås Stad’s structural outline for the western area of the city center with site of Nedre Norrby marked (Borås Stad, 2024).

SITE ANALYSIS

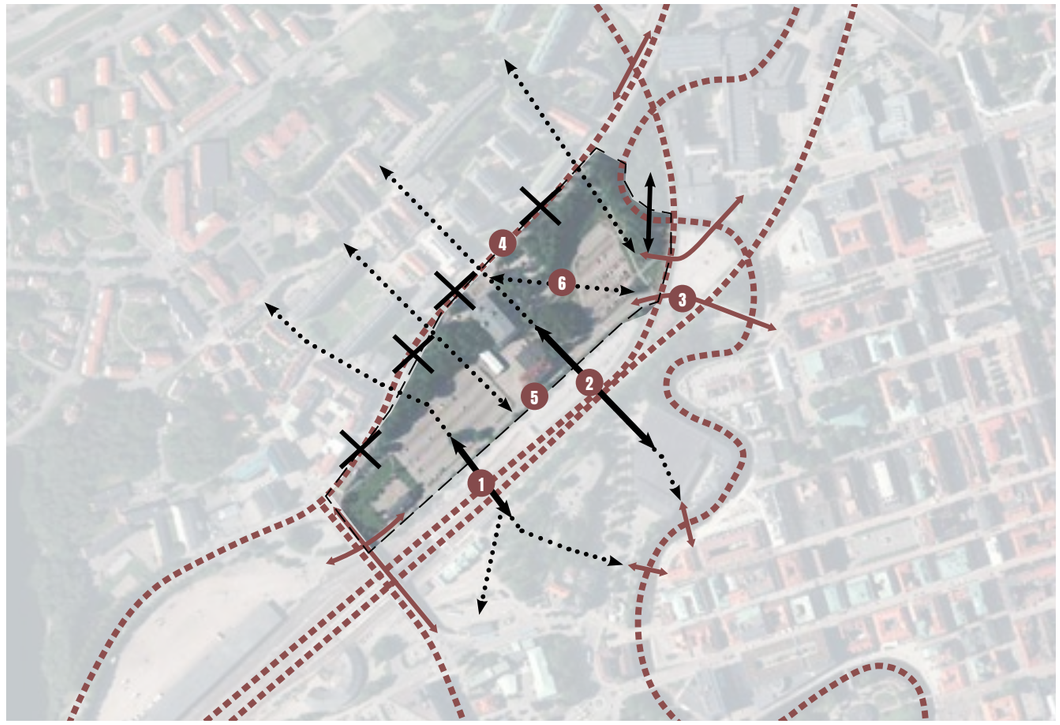
Before moving on to the explorations and the design proposal, site analysis have been made within this thesis to consider and evaluate Borås Stad's structure outline for Nedre Norrby. The selection of analysis has been made in regards to the challenges presented by Borås Stad. The site analysis includes mapping of barriers, conditions for an active city life, landmarks, sight lines, building aesthetics in the area and conditions for new parks on the site.

In addition to this, conditions based on the scope of the thesis, such as the green structure of the surrounding areas, have been studied. Links to surrounding green structures is an important basic condition for ecosystem services. Existing vegetation on the site today has also been inventoried. Existing ecosystem services have been mapped using a biotope area factor calculation.

The site analysis have been compiled based on the summary of Borås Stad's visions for Nedre Norrby. Site analysis have been done through site visits and with maps from Lantmäteriet.

1. Create new connections over the railway to link Norrby with the city.
As mentioned before, Nedre Norrby is surrounded in all directions by barriers. In order to achieve Borås Stad's vision for Nedre Norrby, these need to be either removed or bridged. With the two proposed bridges (marked as 1 and 2 in figure 23) from Borås Stad's structure outline, together with the existing tunnels under the railroads (marked as 3 in figure 23), the barrier effect of the railroads would decrease significantly. To reduce the barrier effect between Norrby and Nedre Norrby, Borås Stad proposes to reduce the capacity of Norrby Långata and prevent through traffic (marked as 4 in figure 23). Traffic is instead directed to Magasinsgatan (marked as 5 in figure 23). Placing the road alongside the railway will create one barrier instead of two.

To strengthen Norrby's connectivity, the new connections across the barriers should have a continuation into the existing street network in Norrby, to create effective connections. This would increase the so-called betweeness through the area.



Barrier *Connections: Bridge or/and tunnel* *Removed barrier* *Desired connections: Bridge or/and tunnel*
Desired continuation of paths

Fig 23. Analysis of barriers and connections (map in background from Lantmäteriet, 2024).

One connection that I see as desirable that is not pointed out in the structure outline, is the diagonal connection between the eastern railroad tunnels for Magasinsgatan and the intersection Norrby Långata/ Norrby Tvärgata (marked as 6 in figure 23). This has the potential to be the shortest route for pedestrians moving from Norrby towards the city center.

2. Create a safe and active city life on undeveloped and transformed areas.
Today there are no shops or restaurants in Nedre Norrby. In Norrby, there are several small shops around Norrby torg and along Norrby Långgata. No particular area within Nedre Norrby is identified as a new route or node for commerce in the structure outline. However, Alingsåsvägen is identified as an urban street where commerce is expected to be concentrated. Based on how the area is transformed, I see the potential for new streets and nodes with activities in Nedre Norrby. Especially in proximity to the bridges that can become strong paths through the area for a large number of people.

3. Bridges and buildings that create landmarks should resemble the character and identity of Borås.
From Nedre Norrby, several of Borås' landmarks are visible. These should continue to be visible to promote local identity and facilitate orientation.

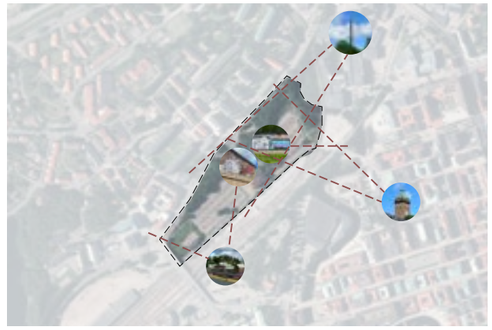
The two planned new bridges can become new visible landmarks for the area. The planned high level of development will also mean potentially tall buildings that could be visible from other parts of the city.

In terms of materials and aesthetics, Borås is still characterized by the years when the industries dominated the city. Classic materials used in these buildings are brick, plaster and wood.

Nedre Norrby is also still characterized by its history as industrial ground. The remaining buildings on the site from the industrial years are of yellow brick with different sheet metal details.

Paths with shops/eating places/activities (Thickness indicates density)
Urban path with shops/eating places/activities in Borås Stad's structure outline
Potential new paths with shops/eating places/activities

Fig 24. Analysis of conditions for an active city life (map in background from Lantmäteriet, 2024).



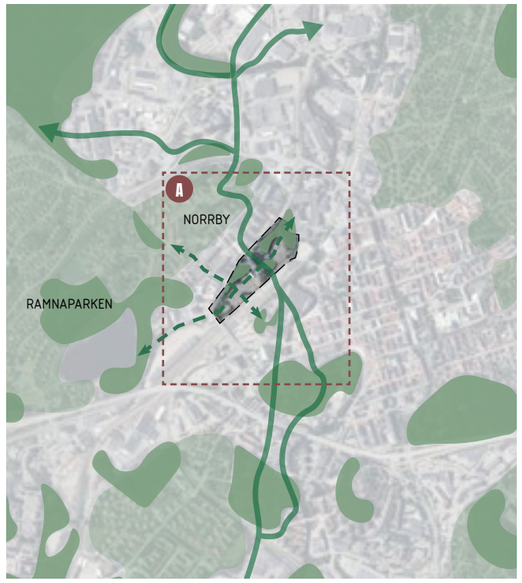
Sight lines to existing landmarks

1. Caroli church, 2. Textile fashion center chimney, 3. Graffitti wall, 4. Mural. Map in background from Lantmäteriet (2024).

Materials historically typical throughout Borås.

Materials on Nedre Norrby site today.

Fig 25. Analysis of landmarks, sight lines and building aesthetics in the area.



Green nature area *Green residential areas* *Planned route for Viskan Park* *Desired connections* *New parks*

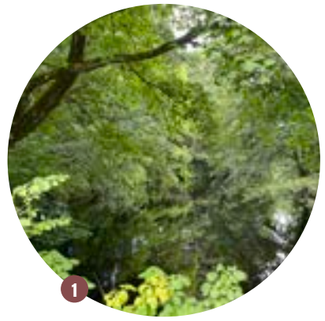
Fig 26. Relations to other green areas and green areas on the site today (map in background from Lantmäteriet, 2024).

4. New parks on Nedre Norrby

There are currently several natural areas on the Nedre Norrby site. Two of these are identified in the structural outline as suitable for parks. These are the area along Viskan at the nothern end of the Nedre Norrby site and the groves along Norrby Långata. I see that the green area around the graffiti wall would be interesting to preserve. Even if it does not have high natural values (consists of quite young birches and lawn today), it still offers a pleasant environment and is a used place today. This area could function as a part of the passing Viskan park.

With the planned Viskan Park, the greenery of Nedre Norrby will be connected to northwest and south-east (via a new bridge). To further strengthen the green connections to the surrounding landscape, it would be desirable to also connect the area with the Ramnaparken area, western Norrby and the northern end of the site along Viskan. The new bridge at the train station could also serve as a green corridor.

A brief inventory of the vegetation on site today has been done, presented in figure 27.

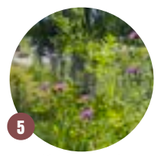


Viskan lined by elms, birches and maples.

Rosehips.

Raspberries.

Groove with birches, aspens and maples.



Knapweed.

Vetch.

Fig 27. A selection of vegetation on the site today.

ECOSYSTEM SERVICES

In 2022, EnviroPlanning AB carried out a mapping and assessment of urban green areas' contribution to green connections and their ability to deliver various ecosystem services, including biodiversity, pollination, noise regulation, air purification and water regulation (Berg & Jonason, 2022). In the inventory, Nedre Norrby's northern area along Viskan is identified as a green area with very high value for connectivity for biodiversity, with the river Viskan as a connecting element (Berg & Jonason, 2022).

There are some groves on the site today, but they are relatively young and have grown unplanned. These woodlands have not been identified in the reports as particularly important for biodiversity.

Based on this, I have made an GYF calculation for the site today. It includes only the ecosystem services in focus of this thesis. As shown in the figure below, the GYF ratio for Nedre Norrby is currently 0.68.

BIOTOPE AREA FACTOR OF THE SITE TODAY

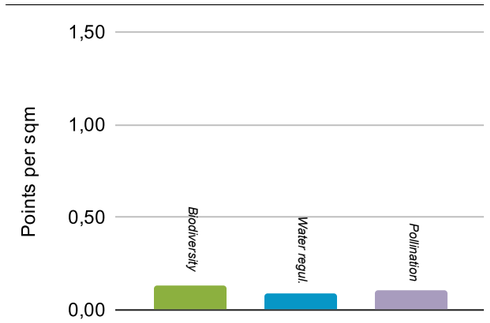
		Surfaces	Amount	Unit
	S0	Hard surfaces	61540	sqm
1	S1/2	Preserved important habitat	3330	sqm
2	S1/2	Preserved nature	9350	sqm
	S1/2	Forest	900	sqm
	S1/2	Bushes	350	sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation	110	sqm
	S1/2	Lawn	7900	sqm
	S1/2	Meadow	4200	sqm
	S1/2	Big tree	18	pieces
	S1/2	Smaller tree/Big plant	59	pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction		sqm
	S2/3	Sedum on construction		sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Fig 28.Calculation of the biotope area factor of the site today.

Green area with very high value
Boundaries of the Nedre Norrby Site

Areas and objects producing ecosystem services at Nedre Norrby today. Legend for surfaces can be found in the table below. Map in background from Lantmäteriet (2024).

Total area:	**75000**	**sqm**	
Total points surfaces:	26693	53	%
Total points qualities:	24082	47	%
TOTAL (eco efficent area)	**50775**		
GYF-quota:		**0,68**	



Note: Calculations made according to the adoptation of the biotope area factor tool in chapter 4, only focusing on biodiversity, water regulation and purification and pollination. Calculations can be found in appendix.

CONCLUSIONS OF SITE ANALYSIS AND PROGRAM

The conclusions of the site analysis, based on site visits and Borås Stad's structure outline, are listed below and summarise what I bring to the exploration and the design phase of this thesis.

1. Create new connections over the railway to link Norrby with the city.
To a large extent I will follow Borås proposal in the structure outline, which means adding two new bridges over the railway (marked as 1 and 2 in figure 29) and that Magasinsgatan is widened and that Norrby Långgata has reduced amount of traffic. However, in the structure outline, existing buildings have not been saved, to make room for a wider Magasinsgatan. In this thesis, I will assume that the widening of Magasinsngatan can be done towards the railway area in order to save existing buildings in the area. The idea is also that Magasinsgatan will handle the transportation of dangerous goods. This means that buildings need to have at least 10 m protection distance from the road, which means that in my work, Magasinsgatan needs to be both moved towards the railway area and widened (marked as 3 and in figure 29).

2. Create a safe and active city life on undeveloped and transformed areas.
I see that Norrby Tvärgata have the potential to become a commercial street as part of one of the new streets between Norrby and the city centre (marked as 4 and in figure 29). The street connects to the existing commercial area around Norrby Torg and the existing business buildings would also be suited for these purposes. Furthermore, Norrby Långata could function as a route for urban life, especially the southern end between the new bridge at the train station and Alingsåsvägen (marked as 5 and in figure 29). There are already some businesses along other parts of the street.

I choose to keep through traffic on Norrby Långgata, unlike Borås Stad's structure outline, which proposes that this should be prevented. I believe that a certain flow of cars on the street would benefit businesses and city life.

3. Bridges and buildings that create landmarks should resemble the character and identity of Borås.
Important landmarks in the area are the Textile Fashion Center's chimney and the Caroli Church. Murals and graffiti paintings in the area contribute with identity for the area. Keeping existing buildings is also a way of linking to the history and identity of the area. Suitable materials for the buildings in the area are brick, plaster and wood. The brownfield character of the area can also be a source of inspiration for the aesthetics of the transformation.

4. New parks on Nedre Norrby.
The structure outline proposes that the nature area along Viskan should be preserved as a park (marked as 6 and in figure 29), that the nature area along Norrby Långgata should be kept as a park (marked as 7 and in figure 29) and that Viskan's park should run through the area along Norrby Tvärgata (marked as 2 and in figure 29). These are also the starting points for me in terms of new parks in the area. Furthermore, I see value in preserving the green area by the graffiti wall and will work on the basis that this area can be preserved as a park (marked as 8 and in figure 29).

In general, the ambition should be to keep as much of the current greenery as possible to preserve the biodiversity that exists on the site today. To accommodate the amount of buildings Borås wants to build on Nedre Norrby, parts of the slope down from Norrby Långgata may be needed to be built on. In this case, the placement of these buildings should be adapted so that as much greenery as possible can be preserved (area marked as 9 and in figure 29).

To strengthen connectivity between green spaces inside and outside the area, there should also be some kind of green corridors connecting the area in a north-south direction (marked as 10 and in figure 29). I will work on the basis that the new bridge by the railway station (marked as 1 and in figure 29) will function as a green corridor like the bridge for Viskan park.

From an ecosystem service perspective, it is particularly important to preserve the larger natural areas within the area. These contribute to all the ecosystem services studied and are important for biodiversity.

5. Include a variety of housing, but preferably more larger apartments, as this is generally lacking in Norrby today.
This has not been mapped in the site analysis, but will be taken into account in the design phase of the thesis.

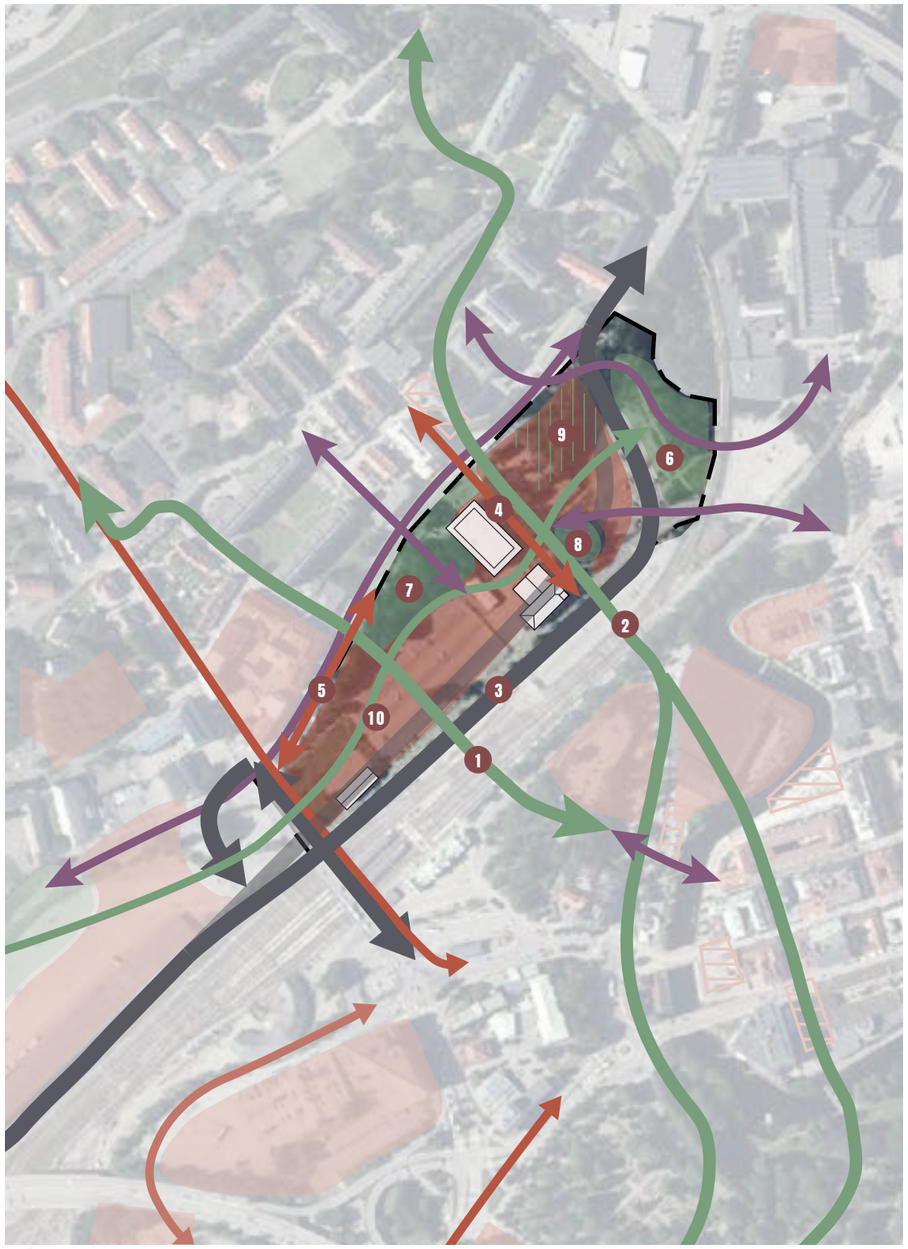
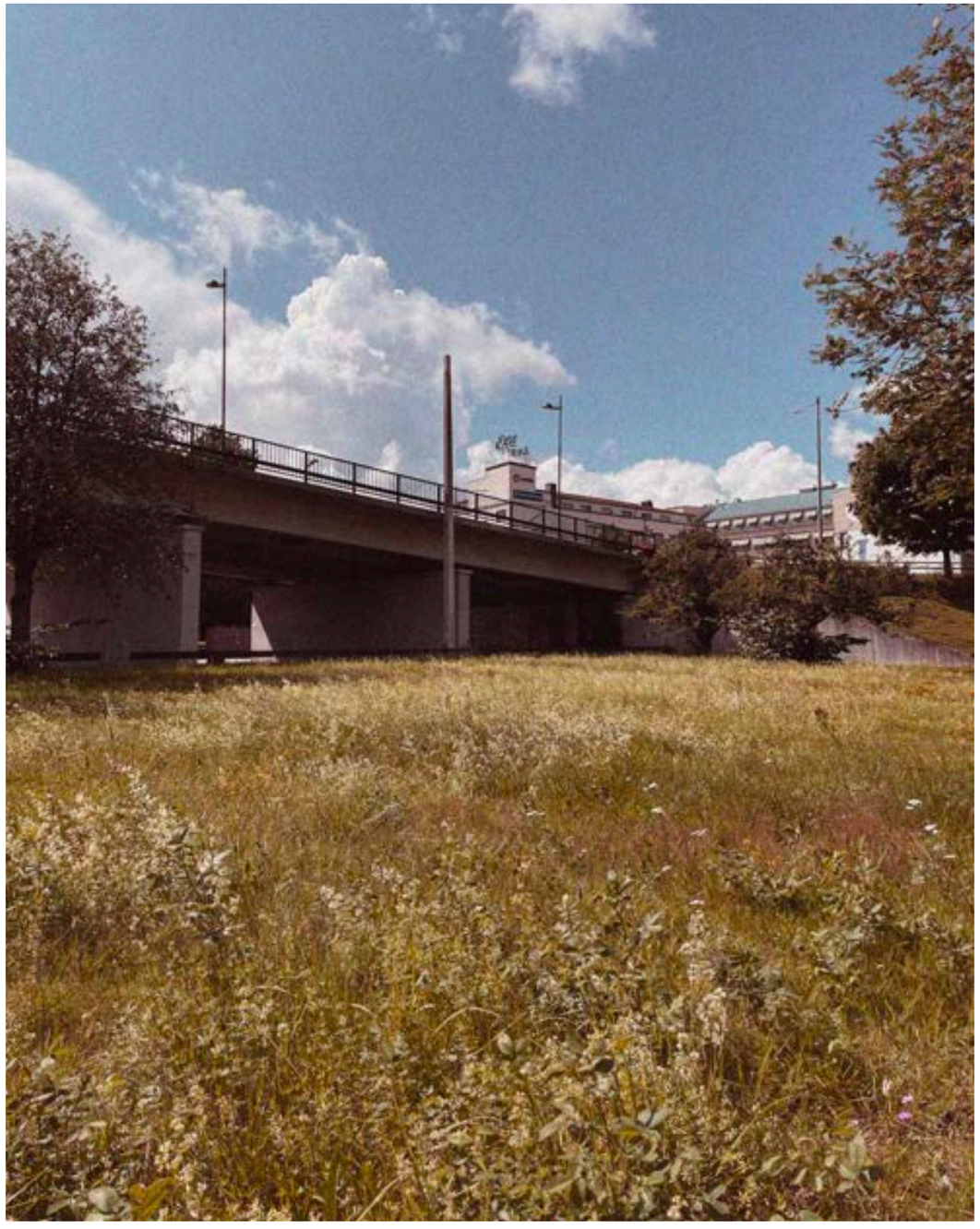


Fig 29. Conclusions of site analysis and Borås Stad's structure outline (map in background from Lantmäteriet, 2024).



4 EXPLORATIONS

EXPLORATION METHOD

In order to form a basis for a design proposal that provide space for new and existing ecosystem services, as well as residential qualities, various urban components and typologies are explored. The purpose for this is to see what the different components and compositions of the design mean to ecosystem services and residential qualities. Ecosystem services are measured with a biotope area factor and residential qualities are mapped by studying a representative dwelling for each typology in relation to the outdoor environment.

COMPONENTS

First, components of the urban environment are explored. In this work, the urban components where ecosystem services can be generated have been divided into five categories: nature/park, yards, streets, green roofs and vertical vegetation (see figure 30).

To see to what extent the different components contribute to ecosystem services and what type of ecosystem services, the biotope area factor tool GYF 3.0 has been used to score the different components.

TYPOLOGIES

The exploration of the different components provides a basis for investigating how the composition of the components affect ecosystem services and residential qualities.

This composite exploration is based on investigating the application of four different building typologies on the Nedre Norrby site. The typologies are closed blocks, slab block, semi-open blocks and towers, according to exploration principles by Spacescape (2024) (see figure 31). The different typologies generate different footprints from buildings, amount of space for streets or yards for example, which affects the conditions for ecosystem services.

A characteristic dwelling for each typology is used for the exploration of residential qualities with different types of interfaces to the outdoors and different types of private outdoor spaces. The biotope area factor of the components calculated in the previous exploration is used to provide a biotope area factor on the composite exploration.

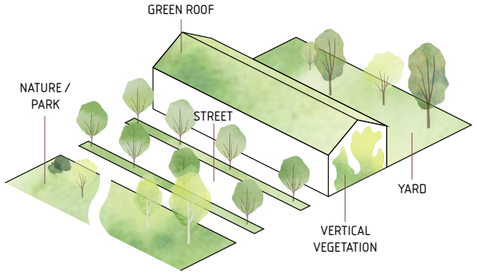


Fig 30. The different components providing ecosystem services in the urban environment.

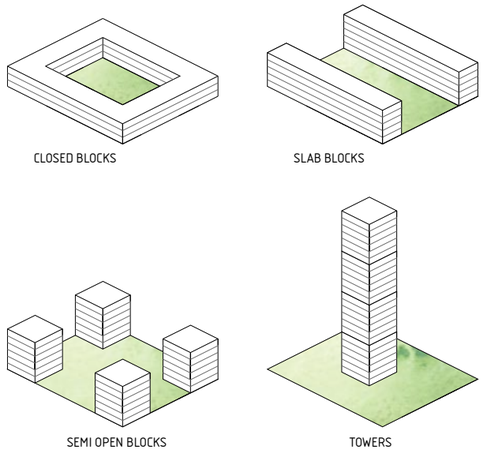


Fig 31. The different typologies, all with the same exploitation rate based on illustration of Spacescape (2024).

EVALUATION TOOLS

ADAPTATION OF BIOTOPE AREA FACTOR TOOL

In this project, the GYF 3.0 tool has been adapted by excluding qualities that do not relate to the choosen ecosystem services.

To make the comparison between the different components effective, point objects in the biotope area factor tool have been excluded, except from trees. This is partly because they have been difficult to map, based on the data used in the explorations, but also because they may require expertise outside the architectural profession to identify. These point objects can also be added or removed more easily than the surfaces and can thus give misleading information on what different types of environments means for ecosystem services. Biodiversity qualities that relate to landscape context have also been excluded from the calculation of components, as this is dependent on context. Figure 32 shows which qualities that are used in this thesis.

SCORING SURFACES

To further simplify the biotope area factor calculations, 18 different types of surfaces and objects have been defined in this thesis, that you will see in figure 33. The purpose of the explorations is to examine from an architect's perspective what types of environments generate what ecosystem services. That is, the focus in this exploration has not been, for example, to investigate which types of flower plantings deliver which ecosystem services, but what ecosystem services do flower plantings deliver in general and compare this with what qualities this bring for residents in terms of usage and aesthetics.

Each type of surface or object has been valued from a general perspective on the ecosystem service qualities they deliver. This is expressed in sqm or pieces. For example: A surface that is similar to a forrest delivers three of the listed qualities: "newly created important habitat outside of landscape context", "permeable vegetation-covered natural surface" and "pollinator-friendly surface". Therefore 1 sqm of forrest counts as 1 sqm of "newly created important habitat outside of landscape context", 1 sqm of "permeable vegetation-covered natural surface" and 1 sqm of "pollinator-friendly surface". However, not all surfaces or objects deliver a value equivalent to their own sqm. For example, the quality "Areas specifically designed for the treatment and retention of stormwater" refers to the size of the area from which a device can handle stormwater. A sedum roof, for example, absorbs about 40% of the rainwater falling on its surface. Therefore, "Areas specifically designed for the treatment and retention of stormwater" are counted as 0.4 sqm

	BIODIVERSITY	Factor
Q2.	Preserved important habitat outside of landscape context	0,8
Q4.	Preserved other nature outside of landscape context	0,6
Q7.	Newly created important habitat outside of landscape context	0,4
Q9.	Newly created other nature outside of landscape context	0,2
	WATER REGULATION AND PURIFICATION	
Q18.	Watercourses used for the treatment and retention of stormwater	0,7
Q19.	Permeable vegetation-covered natural surface	0,5
Q20.	Vegetated temporary floodplain	0,5
Q21.	Areas specifically designed for the treatment and retention of stormwater	0,7
Q22.	Collection of rainwater for irrigation	1
	POLLINATION	
Q29.	Pollinator node	1,3
Q30.	Pollinator-friendly surface	0,8

Fig 32. Qualities used in the biotope area calculations in GYF 3.0.

for 1 sqm of sedum roof, while a rain garden, which handles rainwater from a larger area than its own, counts 1 sqm as 10 sqm as it can handle rainwater from an area about 10 times larger than its own.

The values given for the different qualities for each surface are therefore to be considered as sqm. These values are then multiplied in the GYF 3.0-tool by the weighting factor specified for each quality to score the solution. This is based on its effectiveness in delivering ecosystem services.

The surfaces are primarily scored based on the manual for GYF 3.0 (C/O City, 2023b). If the type of surface has not been specified in the manual, the surface has been assigned a value based on other references as indicated in the table in figure 33.

SURFACE	EXAMPLES/ EXPLANATION	SYMBOL	UNIT	Q6*	Q7	Q8*	Q9	Q18	Q19	Q20	Q21	Q22	Q29	Q30
IMPERMEABLE SURFACES	Impermable surfaces. Asphalt, roofs etc.		1 sqm		-		-	-	-	-	-	-	-	-
FOREST	Multiple layer vegetation, low disdurbance, wild charachter.		1 sqm		1		-	-	1	-	-	-	-	1
BUSHES	Multiple layer vegetation.		1 sqm		-		1	-	1	-	-	-	-	1
RAIN BEDS	Areas specifically designed for stormwater management and purification		1 sqm		-		1	-	1	1	10 [1]	-	-	1
DITCH			1 sqm		-		1	-	1	1	10 [1]	-	-	1
PLANTINGS/ CULTIVATIONS	Flower beds, small scale food farming		1 sqm		-		1	-	1	-	-	-	1 [2]	-
LAWNS	Short cut lawns		1 sqm		-		-	-	1	-	-	-	-	-
MEADOW	Tall grass with meadow character with low-intensity management		1 sqm		-		1	-	1	-	1	-	1 [2]	-
GREEN WALLS/ PLANTS ON STRUCTURES	Ivy, wine		1 sqm		-		0,5 [4]	-	-	-	-	-	-	0,5 [3]
PLANTINGS/CULTIVATIONS/BUSHES ON CONSTRUCTION			1 sqm		-		1	-	-	-	0,6 [1]	-	1 [2]	-
MEADOW ON CONSTRUCTION			1 sqm		-		1	-	-	-	0,6 [1]	-	1 [2]	-
SEDUM ROOF			1 sqm		-		1	-	-	-	0,4 [1]	-	-	1 [2]
LAWNS ON CONSTRUCTION			1 sqm		-		-	-	-	-	0,4 [1]	-	-	-
SMALLER TREE/ LARGER PLANT	Tree height below 10 m		1 piece		-		17 [4]	-	-	-	-	-	-	17 [2]
TREE IN SKELETAL SOIL			1 piece		-		17 [4]	-	-	-	-	17 [4]	-	17 [2]
BIG TREE	Tree height above 10 m		1 piece		25 [4]		-	-	-	-	-	-	-	25 [2]
WATER			1 sqm		1		-	1	-	-	-	-	-	-
WETLAND			1 sqm		1		-	1	-	1	-	-	-	-

*The quality is not calculated for surfaces in the exploration of components except from nature on site. The qualities are also calculated to evaluate the current biotope area factor of the Nedre Norrby site and the design proposal for Nedre Norrby.

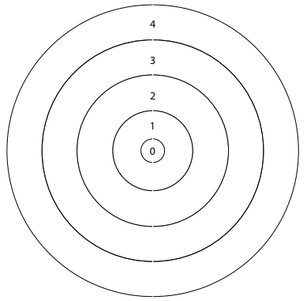
References: 1: (Boverket, 2019c) 2: (Persson, 2012) 3: (Dunnet & Kingsbury, 2004) 4: (Göteborgs Stad, 2024) 5: (VA-guiden, 2024b)

Fig 33. Scoring of surfaces and objects for the component explorations.

To evaluate residential qualities from the outdoor environment in the typology explorations, parameters to map qualities from a resident's perspective have been defined. These are based on the theories of residential qualities presented in chapter 2.

ZONING

The zoning of the relation between indoor and outdoor, made by Bengtsson et al. (2018), forms the basis for mapping residential qualities. The zones are illustrated in the plans and sections for each typology. The qualities are summarised by using the figure below. This shows how closely connected the outdoor qualities are to the dwelling.



0. ZONE WITHOUT CONTACT WITH THE OUTDOOR ENVIRONMENT

1. CONTACT WITH THE OUTDOOR ENVIRONMENT FROM INSIDE THE BUILDING, FOR EXAMPLE THROUGH WINDOWS.

2. CONTACT WITH THE OUTDOOR ENVIRONMENT IN THE TRANSITION ZONE BETWEEN INSIDE AND OUTSIDE, FOR EXAMPLE ON BALCONIES, PATIOS AND TERRACES.

3. CONTACT WITH YARDS AND GARDENS, DIRECTLY ADJACENT TO THE BUILDING

4. CONTACT WITH THE EXTERNAL ENVIRONMENT, I.E. OUTSIDE THE BUILDING AND ITS IMMEDIATE SURROUNDINGS, LIKE PARKS.

Fig 34. Figure for compiling the residential qualities per zone.

OUTDOOR ACTIVITIES

The listed outdoor activities are inspired by the examples given by Eva Kristensson (2007) in the functions of outdoor areas. The conditions for the activities have been defined in this thesis in the following way:

Sunbathing
Area that fits seating and has access to sunlight.

Outdoor cooking
Opportunities to cook outdoors with a fire, such as a charcoal grill or with a gas grill. In Sweden, barbecuing is generally not permitted on balconies or terraces in apartment buildings, although it is not prohibited by law (MSB, 2021).

Seating for outdoor meals
Space for four people or more to eat together seated at a table.

Gardening
Proper space for gardening. Minimum 1 sqm of space.

Playing areas
Playing space for small children, like a sandbox, a playground or smaller patches of grass. Minimum 10 sqm of space.

Larger activity areas
Playing space for children for activities that demand larger open spaces, like sports. Minimum 100 sqm of space.

PRIVACY

Since privacy is a fundamental asset of the home, the level of privacy is evaluated in the different zones on a scale from private to public. The scale used in this thesis has been divided into the following seven steps:

Examples

No private character at all

Residential yard without clear boundaries between public and private

Enclosed residential courtyard

Private frontyard of a detached house

Indoors, with risk of being observed/ Private backyard of a detached house

Indoors, small risk of being observed

Completely private, free from being observed

IMPRESSION OF NATURE

The starting point for assessing the biophilic qualities of the outdoor environment is by evaluating how nature-like environments are. As mentioned, people experience nature differently and have different preferences. However, this scale aims to show how nature-like the experience is, which by the biophilia theory are perceived to promote well being.

This evaluation describes which biophilic attributes are experienced, how the attributes are composed and which senses are used. In this work, a selection of biophilic design elements have been made that relate to the direct experience of nature. These are:

1. Light
2. Air
3. Water
4. Plants
6. Natural landscapes and ecosystems
7. Weather
8. Views

From this, a scale has been made, with seven grades of impressions of nature for different environments. These grades have been defined through examples of how elements of nature can influence a space. Indoor environments and outdoor environments generates different levels of impressions of nature because the outdoor environment involves the use of more human senses, such as smell, hearing and touch, resulting in a stronger experience of nature. The more attributes, complexity and senses activated, the stronger the experience of nature is. In figure 35, there are examples of the different environments.

For the attribute *21. Organized complexity*, a scale of 5 steps have been used to differentiate the environments from very structured to a more organic composition.

There are different examples of the same grade depending on if the environment features a surrounding landscape or not.

Impression of nature, scale:

1 2 3 4 5 6 7

Least nature — *Most nature*

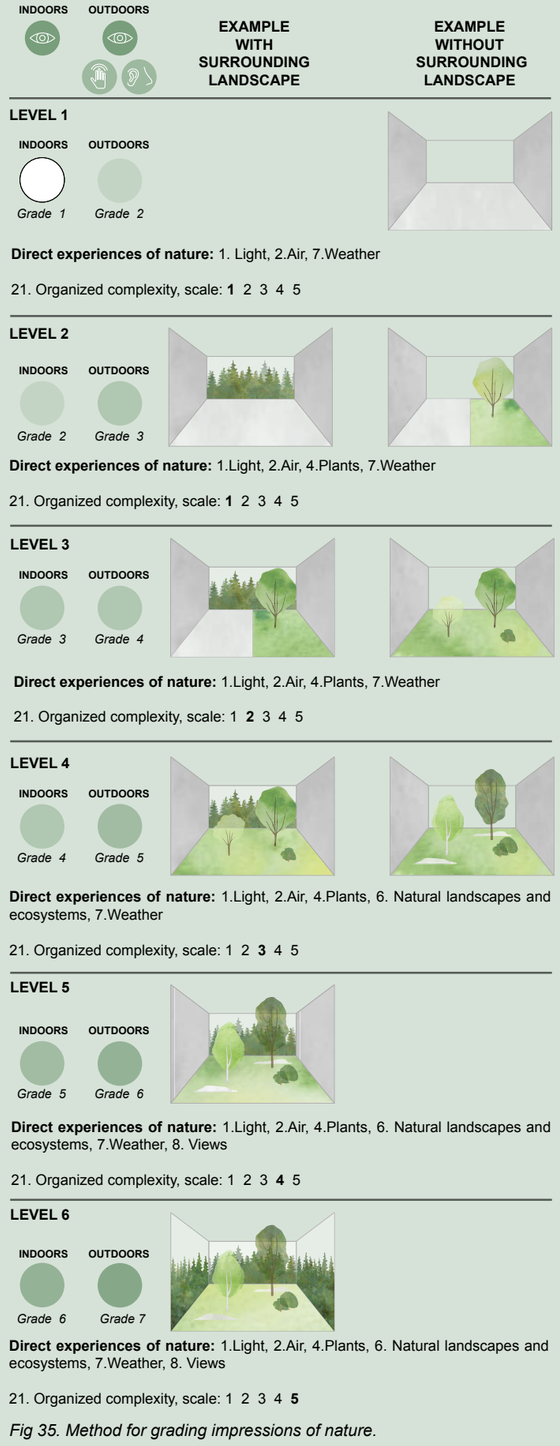


Fig 35. Method for grading impressions of nature.

COMPONENT EXPLORATION

As a starting point for the exploration of the different components, project references have been used. The ambition is to have a range in what ecosystem services and other functions they provide. The aim for the use of the references is to showcase principle solutions for different types of environments generating different attributes. 2-4 examples per type of component was explored. In some cases, the references have been interpreted freely and/or adapted to suit the scale or requirements of this thesis. Often, a section of the components are picked to make the exploration feasible.

This means that the calculation of biotope area factor on the components represents the principal solution in relation to this exploration, rather than a representation of the actual reference.

The basis for the biotope area factor calculation is orthophotos from Lantmäteriet (2024), together with pictures of sites or site visits of the project references.

The exploration is carried out by modelling a representation of the reference in SketchUp, measure the biotope area factor with the tool GYF 3.0 and identify which residential qualities are produced.

Figure 36 shows examples of how the biotope area calculations have been made. In figure 37, a summary of all the studied components in the explorations can be found. The full calculations for each component can be found in the appendix.

EXAMPLES

NATURE/PARK 3

Reference: Stadsparken, Borås

The main park in Borås. English garden style.

STREET 2

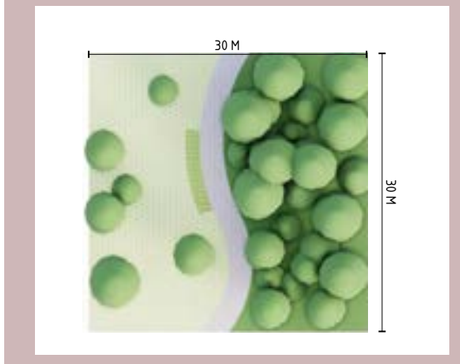
Reference: Strandbodgatan, Uppsala

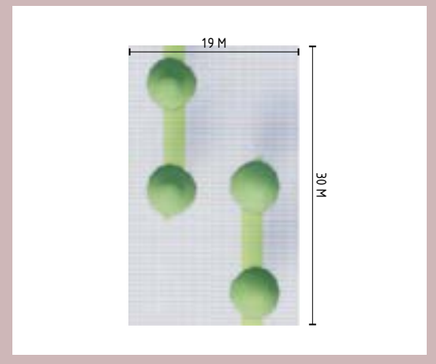
Urban street with rain gardens to handle water regulation and purification. The street includes avenues of trees and parking pockets.

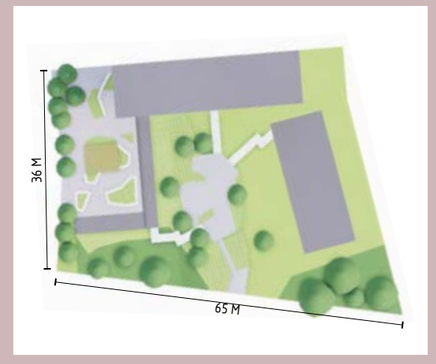
YARD 1

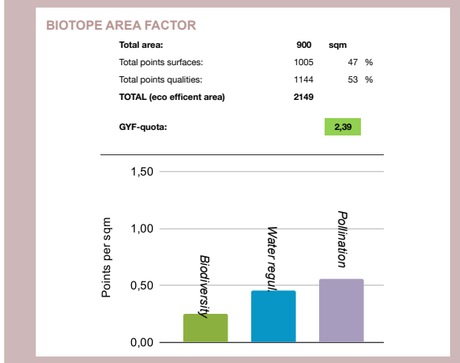
Reference: Brf Viva, Gothenburg

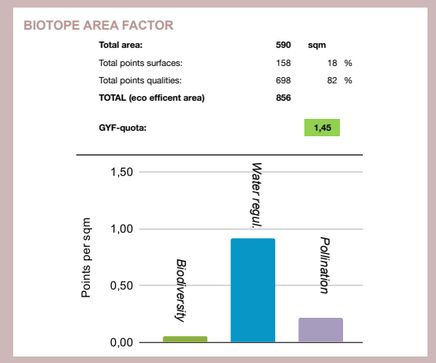
The Brf Viva project aimed to strengthen and add ecosystem services to the site. The courtyard has been adapted to the site's landscape.











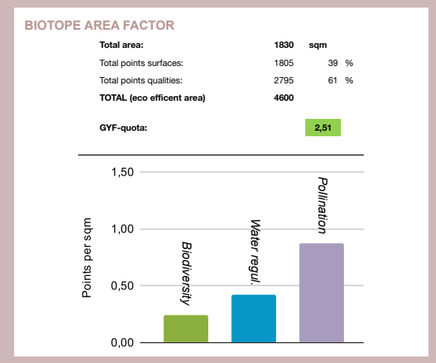
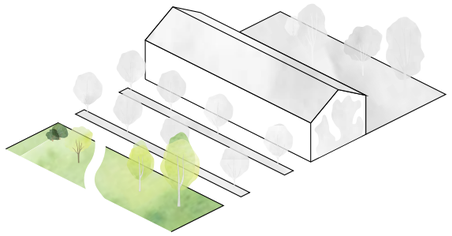


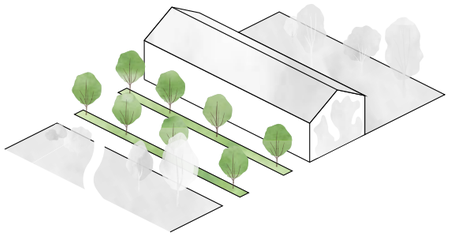
Fig 36. Example of calculation of biotope area factor for components.

SUMMARY COMPONENTS



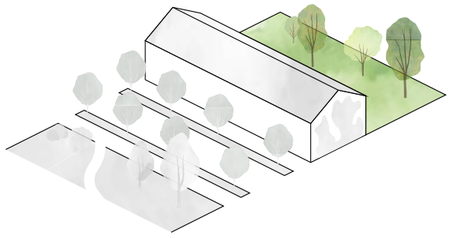
NATURE AND PARKS

Nr	Reference	GYF-quota	Points per sqm Bio.	Wat.	Pol.
1	Forest Nedre Norrby	**3,10**	0,8	0,5	0,8
2	Meadow at Nedre Norrby	**3,86**	0,8	0,54	1,40
3	Stadsparken, Borås	**2,39**	0,25	0,46	0,56
	Average nature/park	**3,12**	**0,62**	**0,5**	**0,92**



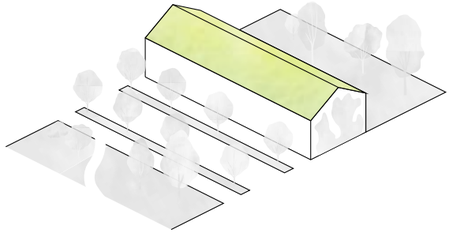
STREETS

Nr	Reference	GYF-	Points per sqm Bio.	Wat.	Pol.
1	Yxhammargatan, Borås	**0,57**	0,02	0,19	0,09
2	Strandbodgatan, Uppsala	**1,45**	0,05	0,92	0,21
3	Sven Hultins gata, Gothenburg	**2,85**	0,10	1,85	0,43
	Average street	**1,62**	**0,05**	**0,98**	**0,24**



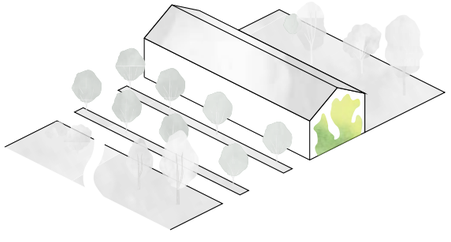
YARDS

Nr	Reference	GYF-quota	Points per sqm Bio.	Wat.	Pol.
1	Brf Viva, Gothenburg	**2,51**	0,24	0,42	0,87
2	Kv Botanikern, Uppsala	**1,43**	0,10	0,11	0,62
3	Bo01 Salongen 5, Malmö	**1,97**	0,13	0,27	0,55
4	Richertsgatan, Gothenburg	**1,50**	0,03	0,43	0,11
	Average yard	**1,85**	**0,13**	**0,3**	**0,54**



ROOFS

Nr	Reference	GYF-quota	Points per sqm Bio.	Wat.	Pol.
1	Brf Viva, Gothenburg	**1,93**	0,18	0,18	0,70
2	Bergakungen, Göteborg	**2,22**	0,12	0,23	1,00
3	79&Park, Stockholm	**1,17**	0,10	0,10	0,47
	Average roof	**1,77**	**0,13**	**0,17**	**0,72**



VERTICAL VEGETATION

Nr	Reference	GYF-quota	Points per sqm Bio.	Wat.	Pol.
1	Brf Viva, Gothenburg	**1,00**	0,07	0,00	0,27
2	Bosco Verticale, Milano	**1,68**	0,15	0,08	0,72
	Average vertical vegetation	**1,34**	**0,11**	**0,04**	**0,5**

Fig 37. Summary of biotope area factor-quota for each type of component.

TYPOLOGY EXPLORATION

In the typology exploration, two things are studied:

1. How do the tested typologies affect the biotope factor of the area?
2. What residential qualities does the typology offer?

The first step of the typology exploration is done by fitting the same amount of GFA on the Nedre Norrby site (75 000 sqm) in all the four explorations, according to Borås Stad's vision of the transformation of the site. The layout of the site in the typology exploration is based on the site analysis made in chapter 3.

The residential qualities of the typologies have been mapped based on floor plans, sections and photos for the home's relation to the outdoors in zone 1 to 3. The principle that the resident choose to do activities as close to home as possible (Berglund & Jergeby, 1998), is the basis for how the mapping of activities has been done. For example, if you have the conditions for growing plants and do gardening on your terrace, it has then been assumed that this activity will take place there instead of in the shared residential yard. Activities that do not fit into the zones 1 to 3 have been placed in zone 4 on the basis that this zone is the only one that could accommodate the activity for the resident in the typology.

To get a variety in the typology exploration, the aim has been to try to be true to the project reference. That is, the typologies have not been refined to achieve the highest biotope area factor or residential qualities.

The choice of characteristic dwelling has also been made on the basis of getting a variation between the typologies and highlighting the defining conditions of each project reference. In other words, there may be more or less qualitative dwellings within the typology, depending on the floor, orientation and size of the dwelling.

The biotope area factor for the typology has been calculated using representative components from the previous exploration.

Figure 40 describes how the results of the typology explorations have been put together and how it should be read.

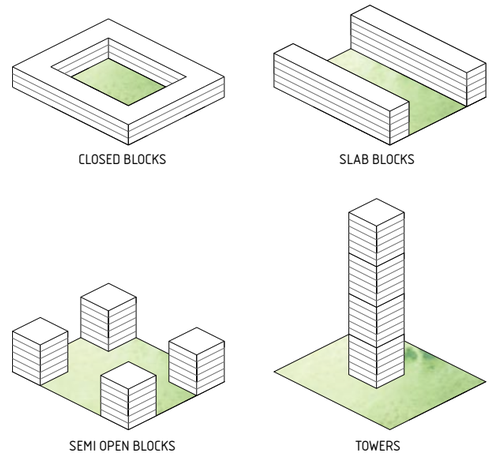


Fig 38. The different typologies, all with the same exploitation rate (based on illustration by Spacescape, 2024).

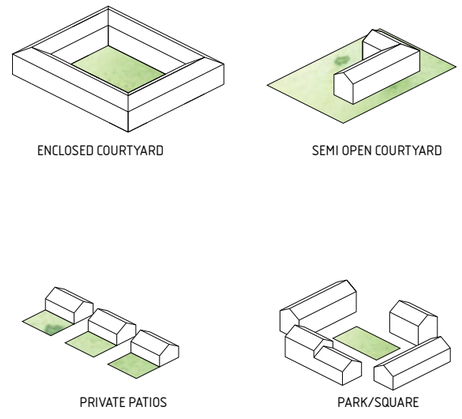


Fig 39. Different types of yards (based on illustration of Minoura, 2019).

TYPOLOGY 1: CLOSED BLOCKS / 79&PARK

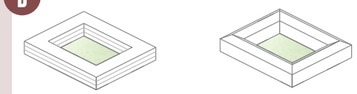
A

79&Park (Wikimedia Commons, 2019).

79&Park is characterized by its roof terraces and the fact that the block structure gradually has fewer floors towards the south to make the courtyard less shaded. The courtyards are on a floor with garages below to accommodate parking spaces for cars.

To reach the target number of GFA at Nedre Norrby in this test, 3-6 floors are used for the development. This means that some areas can still be set aside for parks. The courtyards vary from around 1000 sqm to 1800 sqm.

B



TYPE
Closed blocks

YARD TYPE
Enclosed courtyard

LOCATION
Stockholm, Sweden

PRIVATE SPACES
Terraces, 15%
Balcony, 75 %
Private patios, 10%

Share of biotope area factor scores per ecosystem service

D

BIOTOPE AREA FACTOR

Component	Type	sqm	GYF-quota	Balance (%) Biodiversity	Water purification and regulation	Pollination
Nature/Park	Park	10800	2,85	21	31	48
Streets	Street 2	29950	1,29	4	81	15
Yard on ground		0				
Yard on floor	Yard 2	8000	1,39	10	25	65
Green roofs	Roof 4	14750	1,16	14	20	66
Green walls		0				
Total		63500	1,54	12	48	40
Existing buildings						
Water						

Colour of component in axonometry
Component reference
Biotope area factor for the typology

Fig 41. Calculations of biotope area factor if the Nedre Norrby site where to be built similar to 79&Park. Legend refers to axonometry below.

C

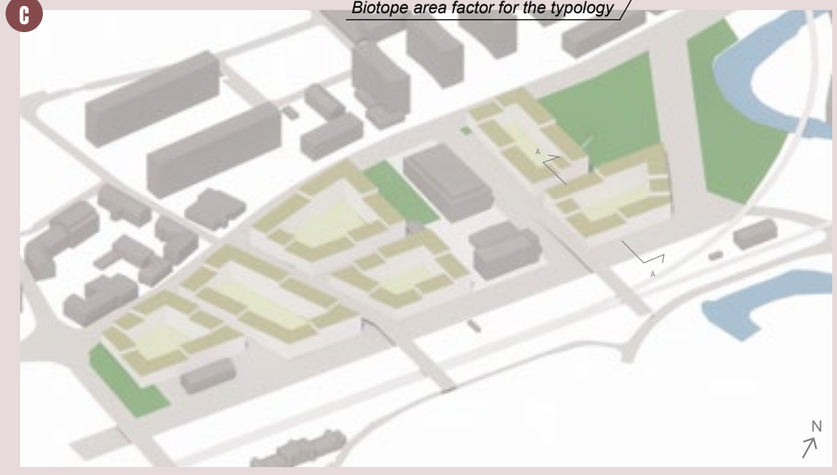


Fig 42. Axonometry of the Nedre Norrby site if it where to be built similar to 79&Park. Scale 1:3000.

A *Reference information and what makes the project interesting as reference.*

B *Information about what main typology, location, type of residential yard and type of private outdoor spaces.*

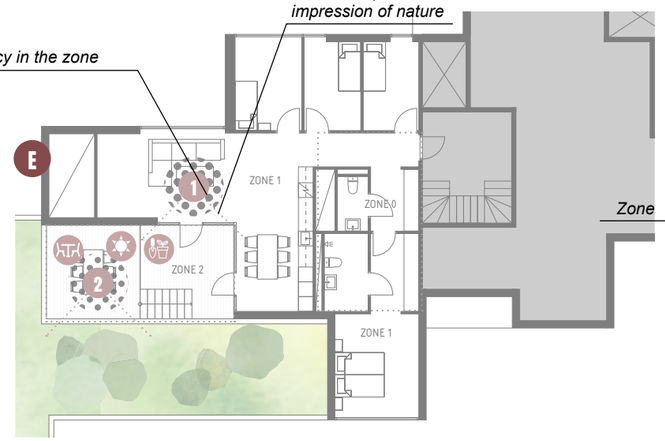
C *Axonometry of the Nedre Norrby area if it where to be built a according to the project reference typology.*

D *Calculation of the biotope area factor by using components from previous exploration.*

Fig 40. Example of how the typology exploration is compiled.

Reference point for impression of nature
Level of privacy in the zone

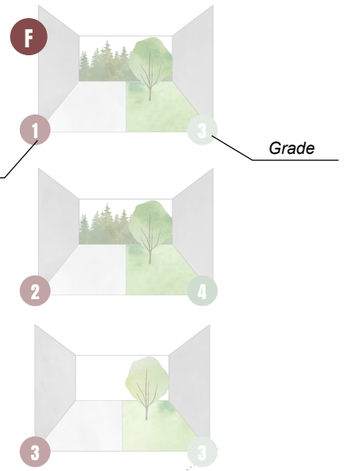
E



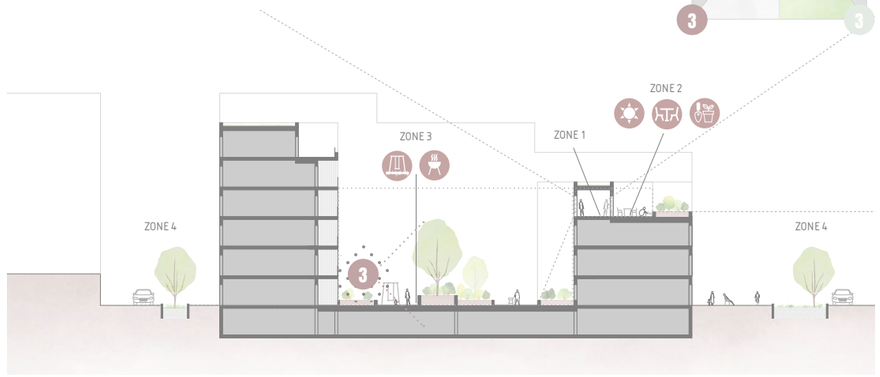
Floor plan of characteristic dwelling. Scale 1:200.

F

IMPRESSION OF NATURE - BY ZONES



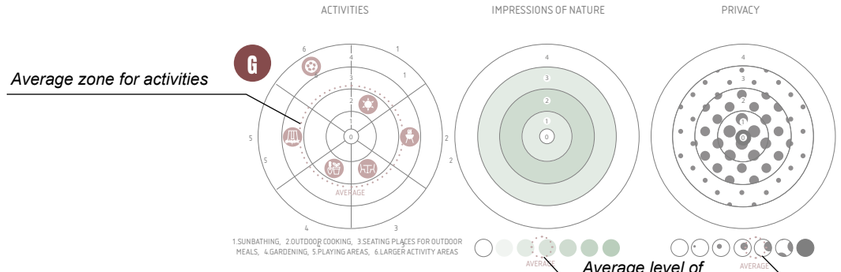
Zone
Grade



Section A-A. Scale 1:500.

SUMMARY RESIDENTIAL QUALITIES - BY ZONES

G



Average zone for activities
Average level of impression of nature
Average level of privacy

Fig 43. Residential qualities for characteristic dwelling in 79&Park.

E *Plan and section of example of dwelling. Residential qualities are marked with the symbols for the different outdoor activities.*

F *Impressions of nature for each zone (in relation to the numbers of biophilic elements).*

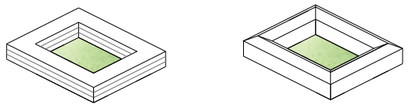
G *Summary of the residential qualities by each zone and the average score.*

TYPOLOGY 1: CLOSED BLOCKS / 79&PARK

79&Park (Wikimedia Commons, 2019).

79&Park is characterized by its roof terraces and the fact that the block structure gradually has fewer floors towards the south to make the courtyard less shaded. The courtyards are on a floor with garages below to accommodate parking spaces for cars.

To reach the target number of GFA at Nedre Norrby in this test, 3-6 floors are used for the development. This means that some areas can still be set aside for parks. The courtyards vary from around 1000 sqm to 1800 sqm.



TYPE
Closed blocks

YARD TYPE
Enclosed courtyard

LOCATION
Stockholm, Sweden

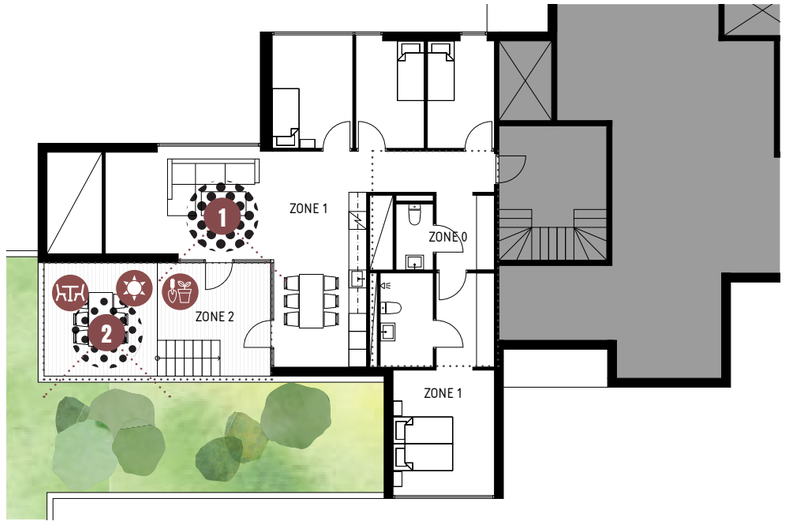
PRIVATE SPACES
Terracces, 15%
Balcony, 75 %
Private patios, 10%

BIOTOPE AREA FACTOR

Component	Type	sqm	GYF-quota	Balance (%) Biodiversity	Water purification and regulation	Pollination
Nature/Park	Park	10800	2,85	21	31	48
Streets	Street 2	29950	1,29	4	81	15
Yard on ground		0				
Yard on floor	Yard 2	8000	1,39	10	25	65
Green roofs	Roof 4	14750	1,16	14	20	66
Green walls		0				
Total		63500	1,54	12	48	40
Existing buildings						
Water						

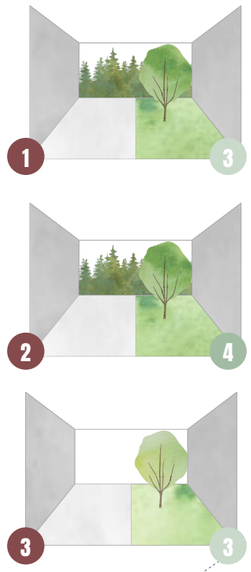
Fig 41. Calculations of biotope area factor if the Nedre Norrby site where to be built similar to 79&Park. Legend refers to axonometry below.

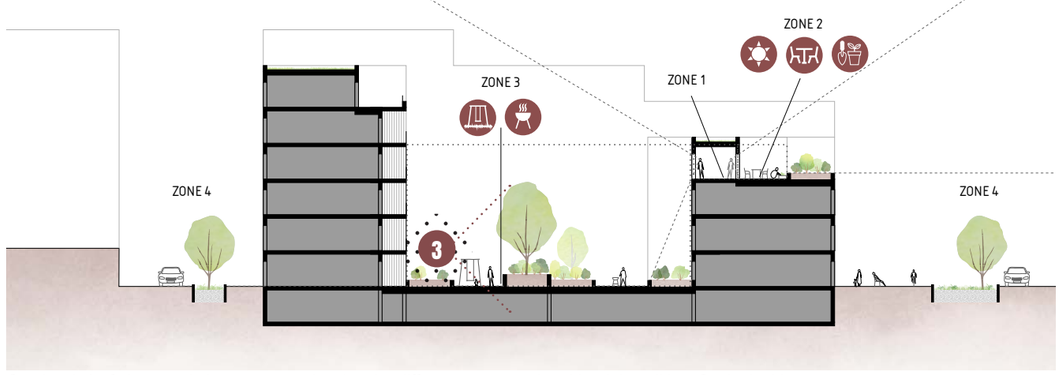
Fig 42. Axonometry of the Nedre Norrby site if it where to be built similar to 79&Park. Scale 1:3000.



Floor plan of characteristic apartment. Scale 1:200.

IMPRESSION OF NATURE - BY ZONES





Section A-A of characteristic apartment showing the different zones and residential qualities. Scale 1:500.

SUMMARY RESIDENTIAL QUALITIES - BY ZONES

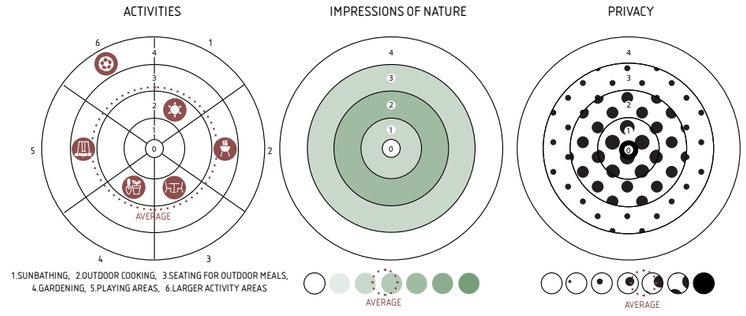
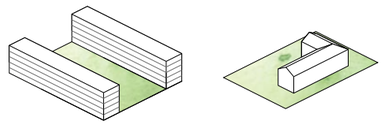


Fig 43. Residential qualities for a characteristic dwelling in 79&Park.

Brf Viva.

Brf Viva is characterized by its nature-like yards and gallery access. The residential courtyards are partially on floor with garages below to accommodate parking spaces for cars and bikes. Despite the fact that Brf Viva consists of slab houses, the yard structure is relatively closed.

To achieve the target number of GFAs at Nedre Norrby in this test, 4-8 floors are used for the development. This means that some smaller areas can be set aside for parks. The courtyard sizes are about 1000 sqm.



TYPE
Slab blocks

YARD TYPE
Semi-open yards

LOCATION
Gothenburg, Sweden

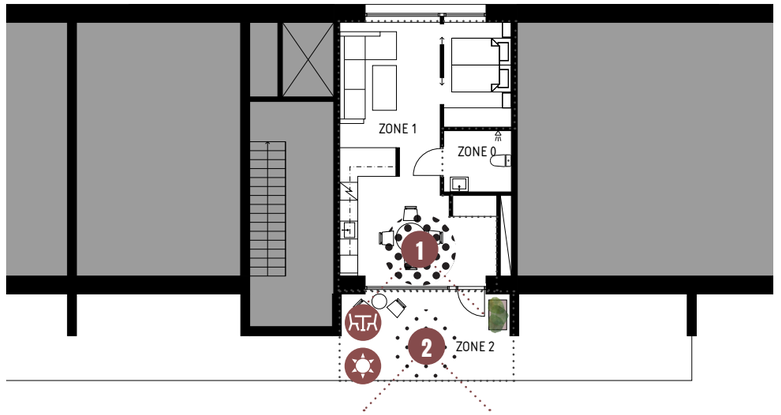
PRIVATE SPACES
Gallery, 50 %
Gallery and Balcony, 50 %

BIOTOPE AREA FACTOR

Component	Type	sqm	GYF-quota	Balance (%) Biodiversity	Water purification and regulation	Pollination
Nature/Park	Park	3550	2,85	21	31	48
Streets	Street 2	29250	1,29	4	81	15
Yard on ground	Yard 1	14700	2,33	16	28	56
Yard on floor	Yard 1	6500	2,33	16	28	56
Green roofs	Roof 4	11000	1,16	14	20	66
Green walls	Wall 1	3800	1	20		80
Total		63500	1,79	12	44	44
Existing buildings						
Water						

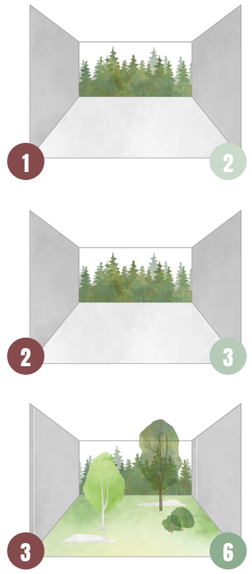
Fig 44. Calculations of biotope area factor if the Nedre Norrby site where to be built similar to Brf Viva. Legend refers to axonometry below.

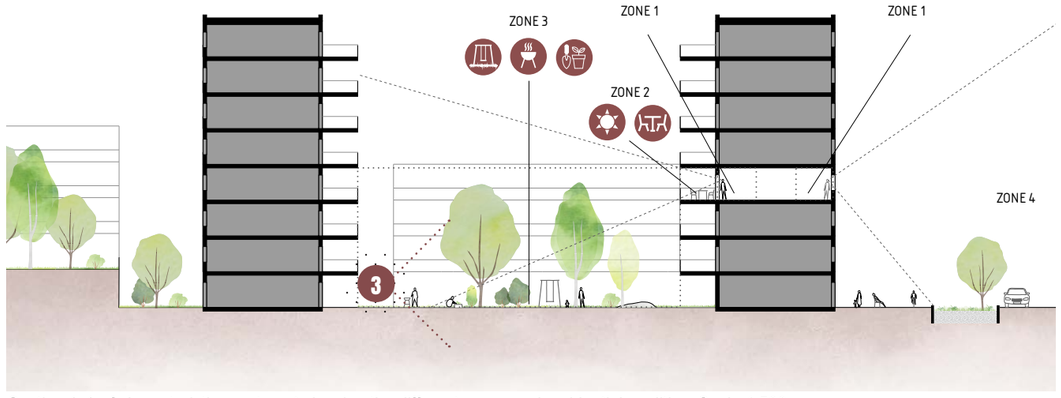
Fig 45. Axonometry of the Nedre Norrby site if it where to be built similar to Brf Viva. Scale 1:3000.



Floorplan of characteristic apartment. Scale 1:200.

IMPRESSION OF NATURE - BY ZONES





Section A-A of characteristic apartment showing the different zones and residential qualities. Scale 1:500.

SUMMARY RESIDENTIAL QUALITIES - BY ZONES

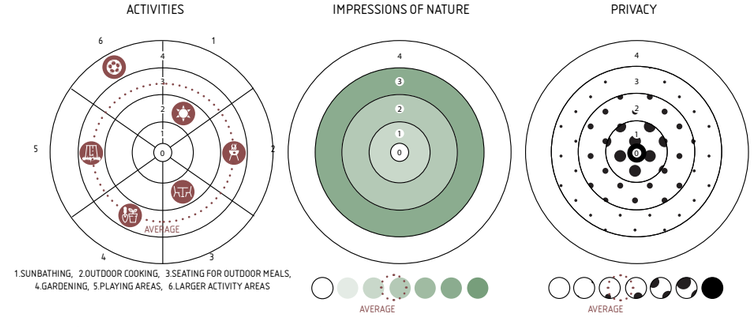


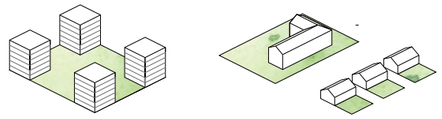
Fig 46. Residential qualities for a characteristic dwelling in Brf Viva.

TYPOLOGY 3: SEMI-OPEN BLOCKS / BO01 (SALONGEN 5)

Bo01 (Wikimedia Commons, 2014).

The Bo01 area in Västra hamnen Malmö consists of both taller and lower buildings with a semi-open block structure. The buildings vary from two-storey town houses to apartment buildings with seven floors. The residential courtyards are partially on floors with garages below to accommodate parking spaces. The area consits of smaller properties resulting in subdivided courtyards.

In order to reach the target number of GFA at Nedre Norrby in this test, 2-7 floors are used for the buildings. The courtyards are about 1200 sqm but divided into smaller properties.



TYPE
Semi-open blocks

YARD TYPE
Semi-open yards/
Private patios

LOCATION
Malmö, Sweden

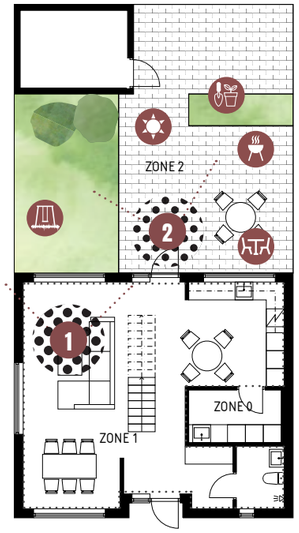
PRIVATE SPACES
Private patios, 25%
Balcony, 55%
Terraces, 20%

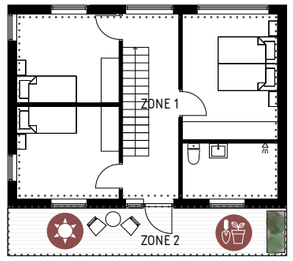
BIOTOPE AREA FACTOR

Component	Type	sqm	GYF-quota	Balance (%) Biodiversity	Water purification and regulation	Pollination
Nature/Park		0				
Streets	Street 2	29850	1,29	4	81	15
Yard on ground	Yard 3	13700	1,69	11	39	50
Yard on floor	Yard 2	4800	1,39	10	25	65
Green roofs	Roof 1	11000	1,93	17	17	66
Green walls		0				
Total		63500	1,41	9	51	40
Existing buildings						
Water						

Fig 47. Calculations of biotope area factor if the Nedre Norrby site where to be built similar to Bo01. Legend refers to axonometry below.

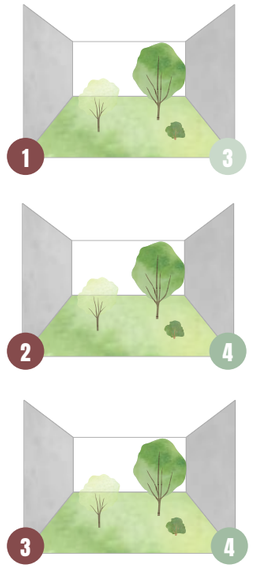
Fig 48. Axonometry of the Nedre Norrby site if it where to be built similar to Bo01. Scale 1:3000.

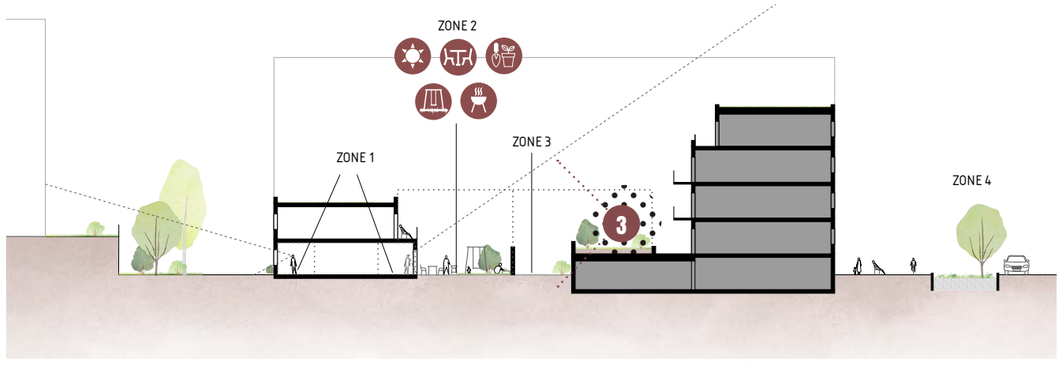




Floorplans of characteristic dwelling. Scale 1:200.

IMPRESSION OF NATURE - BY ZONES





Section A-A of characteristic dwelling showing the different zones and residential qualities. Scale 1:500.

SUMMARY RESIDENTIAL QUALITIES - BY ZONES

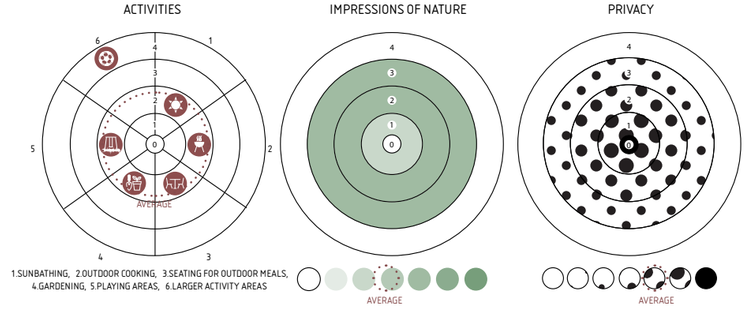
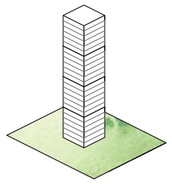


Fig 49. Residential qualities for a characteristic dwelling in Bo01.

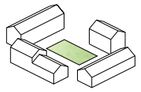
Bosco Verticale (Wikipedia contributors, 2024).

Bosco Verticale is characterized by its extensively green balconies, which make the greenery present even at higher heights of the building. Bosco Verticale consists of two towers, 26 and 18 stories high.

In order to reach the target GFA at Nedre Norrby in this test, 8 and 15 storeys are used for the development. The building footprint are small, leaving plenty of space for residential yards and parks.



EXPLOTATION TYPE
Towers



YARD TYPE
Park

LOCATION
Milano, Italy

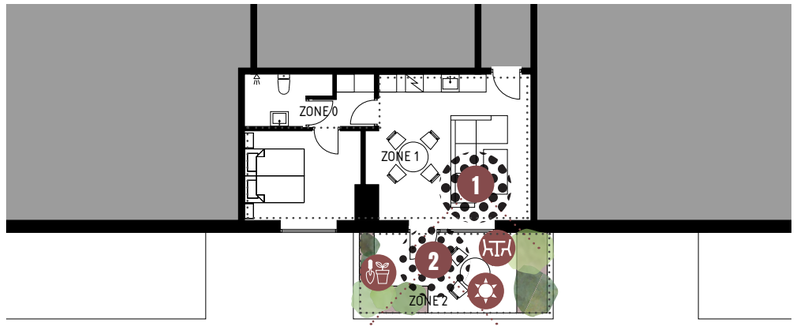
PRIVATE SPACES
Balcony, 100 %

BIOTOPE AREA FACTOR

Component	Type	sqm	GYF-quota	Balance (%) Biodiversity	Water purification and regulation	Pollination
	Component					
Nature/Park	Park	4000	2,85	21	31	48
Streets	Street 2	33350	1,29	4	81	15
Yard on ground	Yard 4	13700	1,46	5	79	16
Yard on floor	Yard 2	6500	1,39	10	25	65
Green roofs		0				
Green walls	Wall 2	22500	1,57	11	35	55
Total		63500	1,87	8	58	34
Existing buildings						
Water						

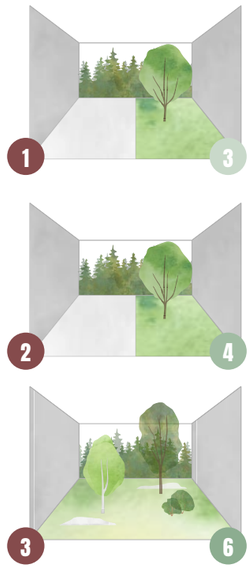
Fig 50. Calculations of biotope area factor if the Nedre Norrby site where to be built similar to Bosco Verticale. Legend refers to axonometry below.

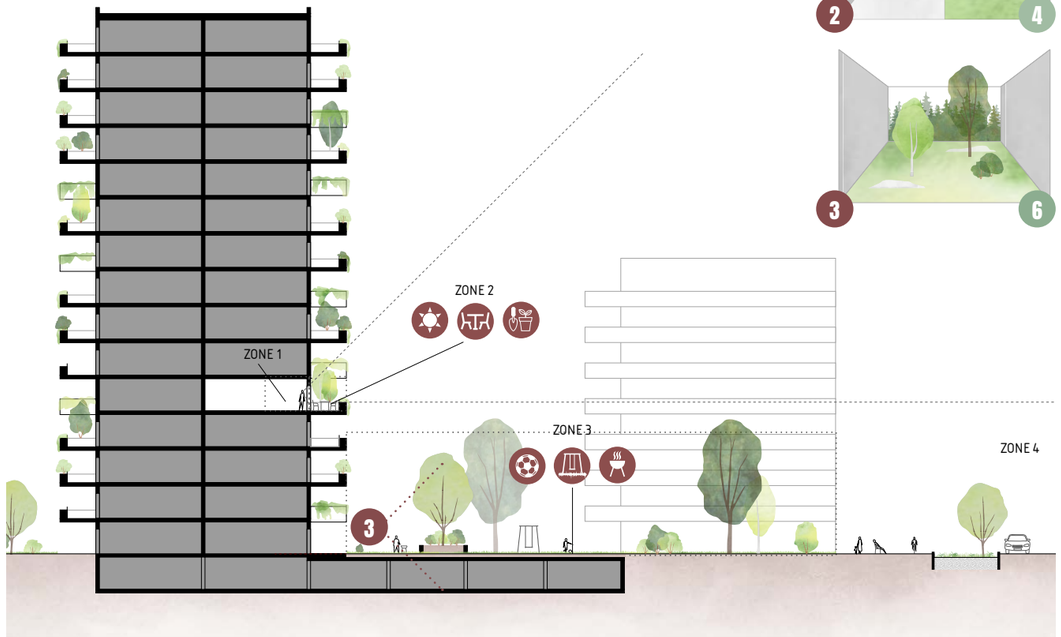
Fig 51. Axonometry of the Nedre Norrby site if it where to be built similar to Bosco Verticale. Scale 1:3000.



Floorplan of characteristic apartment. Scale 1:200.

IMPRESSION OF NATURE - BY ZONES





Section A-A of characteristic apartment showing the different zones and residential qualities. Scale 1:500.

SUMMARY RESIDENTIAL QUALITIES - BY ZONES

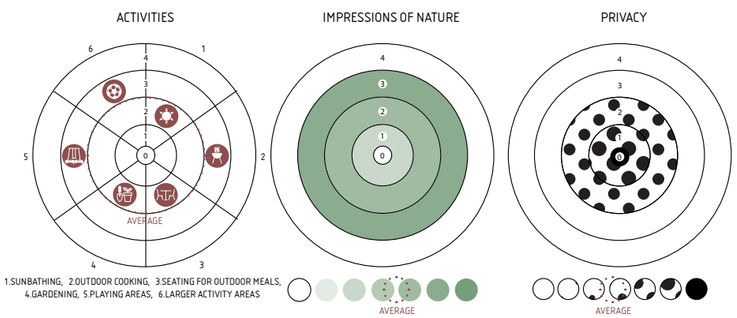


Fig 52. Residential qualities for a characteristic dwelling in Bosco Verticale.

SUMMARY EXPLORATIONS

COMPONENTS

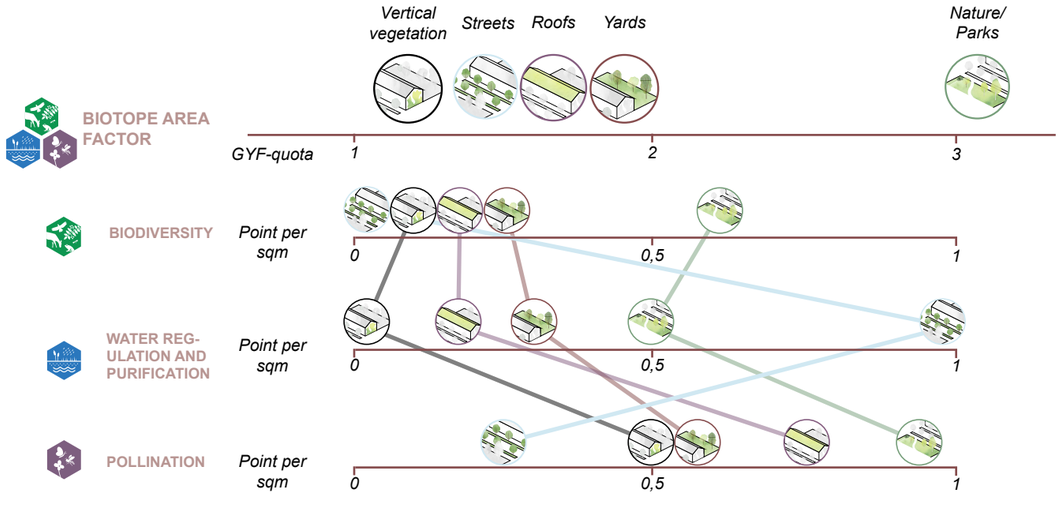


Fig 53. Summary of results from components explorations.

LEARNINGS FROM COMPONENT EXPLORATIONS

The clearest correlation in component exploration is that the greater the proportion of vegetation a surface consists of, the more ecosystem services are generated. If additional vegetation “surfaces” are created, through multi-layered vegetation with ground cover plants, shrubs and trees, more ecosystem services are generated than if there is only one layer of vegetation. Multi-layered vegetation also benefits biodiversity as several types of habitats can be created that support a larger number of species.

One question I had before this test was what it means if plants and green spaces are placed directly on the ground or on a construction, such as a floor, roof or wall. Of the residential yards examined, there was one courtyard built entirely on top of a floor (Kv Botanikern) and one yard built partly on a floor (Brf Viva). Kv Botanikern was the residential yard with the lowest biotope area factor, while Brf Viva was the one with the highest biotope area factor. For Brf Viva, however, it was mainly the part of the yard that was on the ground that contributed with ecosystem services. The conclusion I was able to draw from these examples, compared to the other residential yards, was that the yards on floors contained a significantly larger proportion of hard surface and less vegetation. This means fewer pollinating plants, less vegetation that can absorb storm water and fewer and more uniform habitats. This is probably due to the higher investment and maintenance costs required to create vegetated areas on floors, especially with a larger soil depth, compared to hard surfaces.

In terms of roofs, these could deliver almost as much ecosystem services according to the biotope area factor as residential yards on the ground. This is because they had a small percentage of area that was not covered by vegetation. However, this vegetation also tends to be monotonous. With a larger soil depth, larger plants can also grow on roofs and a larger soil volumes also helps store more water.

The contribution of ecosystem services from vertical vegetation was difficult to assess due to differences in data from previous research. But according to some research, they could in principle generate the same amount of ecosystem services as vegetation on the ground. However, greenery directly on the ground is better able to connect with surrounding green spaces and other terrestrial and aquatic ecosystems.

A clear result from the component exploration was that streets were the highest scoring component in terms of stormwater management based on the examples studied. This was due to the fact that several of these had specific solutions for this purpose, such as rain beds and ditches.

TYPOLOGIES

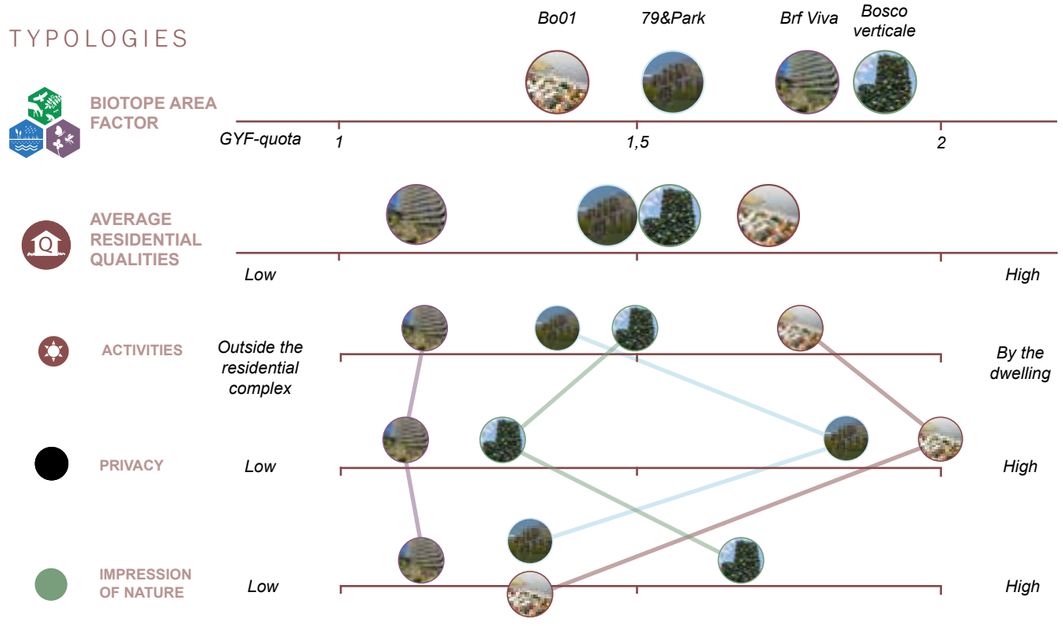


Fig 54. Summary of results from typology explorations.

LEARNINGS FROM TYPOLOGY EXPLORATIONS

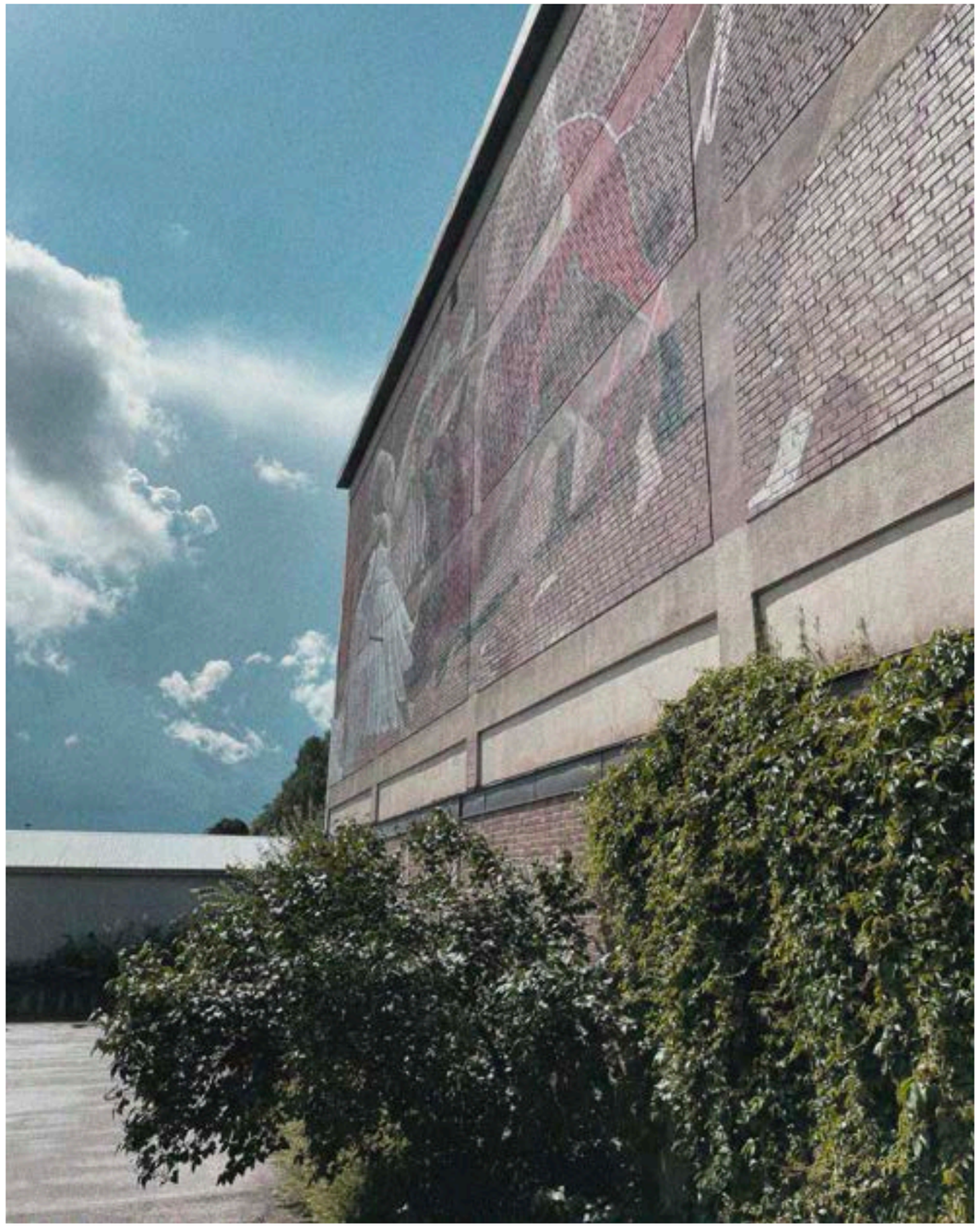
When it comes to biotope area factor and generating ecosystem services, it is not surprising that the tower typology (Bosco Verticale) is most effective. With the largest proportion of yard and park area, there is a lot of vegetation and permable land, which provides good conditions for ecosystem services.

When it comes to residential qualities, a question that I brought into the exploration was what a sparse and taller development compared to a dense and low-rise development means for residential qualities. The tower typology also scored high on this. The Bosco Verticale project reference offers a spacious terrace-like balcony, where several activities can take place in connection to the home and provides a large proportion of impressions of nature. However, this balcony solution requires a reinforced construction to support the heavy balconies because of the soils and plants. The Bosco Verticale has been criticized as this means more use of carbon dioxide-producing concrete and results in expensive housing. If this typology had conventional balconies instead, this typology would have been the one with the lowest residential quality score, as the typical dwelling would be far from the vegetation and activities on the ground.

With lower buildings, more residents are close to the outdoor environment on the ground and can more easily take part in outdoor activities. The lower typologies with a larger footprint from buildings has the potential to more clearly define what is public and private with the formation of the buildings. With lower buildings, a larger proportion can also have patios on the ground, adjacent to their home, or roof terraces. The dwellings with these kind of private outdoor spaces offer the most residential qualities in the explorations. These dwellings offers a spacious outdoor space in connection to the home, including lush vegetation. This generates impression of nature and outdoor activities in a private sphere. Examples of this are 79&Park, Bo01 and Bosco Verticale.

It should be added however, that all the references can be considered to have an unusually high number of residential qualities compared to current housing standards. For example, all the homes studied have large patios that can accommodate meals for 6-8 people.

Although Bosco Verticale clearly had the highest biotope area factor in this exploration, other typologies could have achieved a similar result. For example, by adding vegetation surfaces such as green roofs and walls, or increasing the quality of green spaces. With more layers of vegetation and a larger soil depth, the production of ecosystem services could be increased.



5 DESIGN STRATEGIES

DESIGN STRATEGIES

In this chapter, the results from the explorations and the initial research of the thesis have been summarised into design strategies. The strategies ranges from the urban level, block level to building level.

The icons next to the strategies define if the strategies are a result from the explorations or from the initial research, what ecosystem services they benefit and if the strategy is linked to residential qualities.

The design strategies are general and can be applied to other projects besides the transformation of Nedre Norrby.

ICONS

From explorations

From literature

Benefits biodiversity

Benefits water purification and regulation

Benefits pollination

Benefits residential qualities

URBAN LEVEL

1 REDUCE BUILDING FOOTPRINTS AND IMPERMEABLE GROUND

As the exploration showed, the ground is the most effective surface for generating ecosystem services. By reducing the proportion of impermeable ground and building footprints, basic conditions are provided for a high proportion of greenery in the area generating ecosystem services.

2 DEFINE WHAT IS PRIVATE AND PUBLIC

In order to create privacy for dwellings, a basic condition is to differentiate between public and private. This can be done by creating some type of enclosing yard structure, like some of the studied typologies. It could also be done by other types of spacial interventions, like difference in heights or fences.

3 REDUCE RESIDENTS DISTANCE TO GROUND

It was shown in the exploration that dwellings closer to the ground have more impressions of nature in general and closer to outdoor activities. By keeping building heights low, more residents have contact with outdoor activities and green environments on the ground.

4 USE THE ROOFS

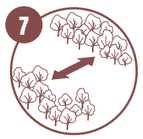
Green roofs can, according to the component exploration, provide a substantial amount of ecosystem services, equal to less vegetated yards. Terraces on green roofs can also provide residential qualities like outdoor activities and impression of nature. This makes roofs an important asset that benefit both ecosystem services and residential qualities.

5 MINIMIZE RESIDENTIAL YARDS ON CONSTRUCTIONS

In the component exploration, it was showed that green spaces on constructions in general don't generate as much ecosystem services as on the ground. Therefore, yards should preferably be placed on the ground. By doing this, vegetation can also grow taller and be visible to more residents.

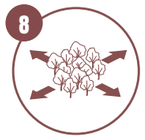
SAVE EXISTING VEGETATION

Saving existing greenery is beneficial for ecosystem services, especially for biodiversity. By preserving existing greenery on the site, existing fauna can spread to and be strengthen by new green areas, benefiting biodiversity.



CONNECT GREEN AREAS

To create strong and resilient ecosystems, new features should be part of larger structures. By connecting vegetation and natural areas, species can move between the areas. Species are in general dependent on more than one type of biotope.



LARGER NATURAL GREEN AREAS ARE NEEDED FOR BIODIVERSITY

Many species are sensitive to disturbance. Therefore, there need to be larger green areas, with less human disturbance. This helps the more disturbance-sensitive species to survive and by that, broadens the biodiversity to not only benefit the disturbance-resistant species. The bigger green areas, the better.

ADAPT THE DESIGN TO THE AREA'S STORM WATER RUNOFF

A basic condition for managing storm water with natural infiltration into the ground, is to adapt the development to the runoff of the site. Both in terms of waterways and retention areas.

USE STREETS FOR STORM WATER REGULATION AND PURIFICATION

The component explorations showed the streetscapes potential to act as waterways. By complementing the streetscape with infiltration facilities, such as trees in skeletal soil or rain beds, storm water can also be delayed and infiltrated into the groundwater. These facilities also create a greener, more pleasant street environment.

PLAN FOR FLOODING

By planning for which areas will be flooded during heavy rainfall, areas with other functions can be prepared to handle flooding and contribute to storm water management.

BLOCK LEVEL

COMBINE WILD AND TAMED VEGETATION

Wild vegetation generally provides more ecosystem services than the more tamed and intensively managed. At the same time, the more tamed vegetation offers activity areas and, in some eyes, aesthetic values. These two types of vegetation therefore need to co-exist.

VERTICALITY OF VEGETATION

Large trees, climbing plants, etc. make nature visible for dwellings higher up in buildings. This is an important asset for taller buildings. Vertical vegetations on walls can also provide ecosystem services.

LOW-INTENSITY MAINTENANCE ON GREEN AREAS

Biodiversity increases when the level of management is not too intensive. However, some lower level of disturbance can promote biodiversity. In that way, the strongest species do not take over completely. With a certain degree of disturbance, those species that thrive when, for example, soil surfaces are not overgrown with tall grass, are given the chance to grow.

MULTIPLE LAYERS OF VEGETATION

Multiple layers of vegetation such as ground covering plants, bushes and trees have several benefits. With more layer of vegetation, absorption of storm water is more effective. It is also positive for biodiversity as multiple layers of vegetation provide a more nature like environment, with several different habitats. These environments can also provide food and nesting sites for several types of pollinators.

OUTDOOR PRIVACY

Being able to use the outdoor environment without feeling observed is a fundamental condition for using the outdoor environment. By creating separate rooms outdoors, courtyards and parks can be used by more people or groups at the same time. This can for example be done by using hedges, lines of trees and differences in heights.

YARDS OF SUFFICIENT SIZE

A good size of a yard is between 1 500 and 2 500 sqm of connected space. Using this size, the yard should be able to offer sufficient sunlight in the yard. Per housing unit, the space should be at least 10 sqm to generate space for multiple types of outdoor activities and allow several activities to happen at same time, without disturbing each other. To give the yard a private feeling, it shouldn't be too big or shared by too many dwellings, maximum 200 units.

USE SPONTANEOUS VEGETATION AND LOCAL SPECIES

Local plant species fulfill functions in the local ecosystem and are adapted to the local climate, which also simplifies the management of the plants. Spontaneous vegetation means that plants establish themselves spontaneously, i.e. are not planted. In other words, these plants have the right conditions to grow on the site. These are usually local species, which in this way also help to strengthen the local ecosystem.

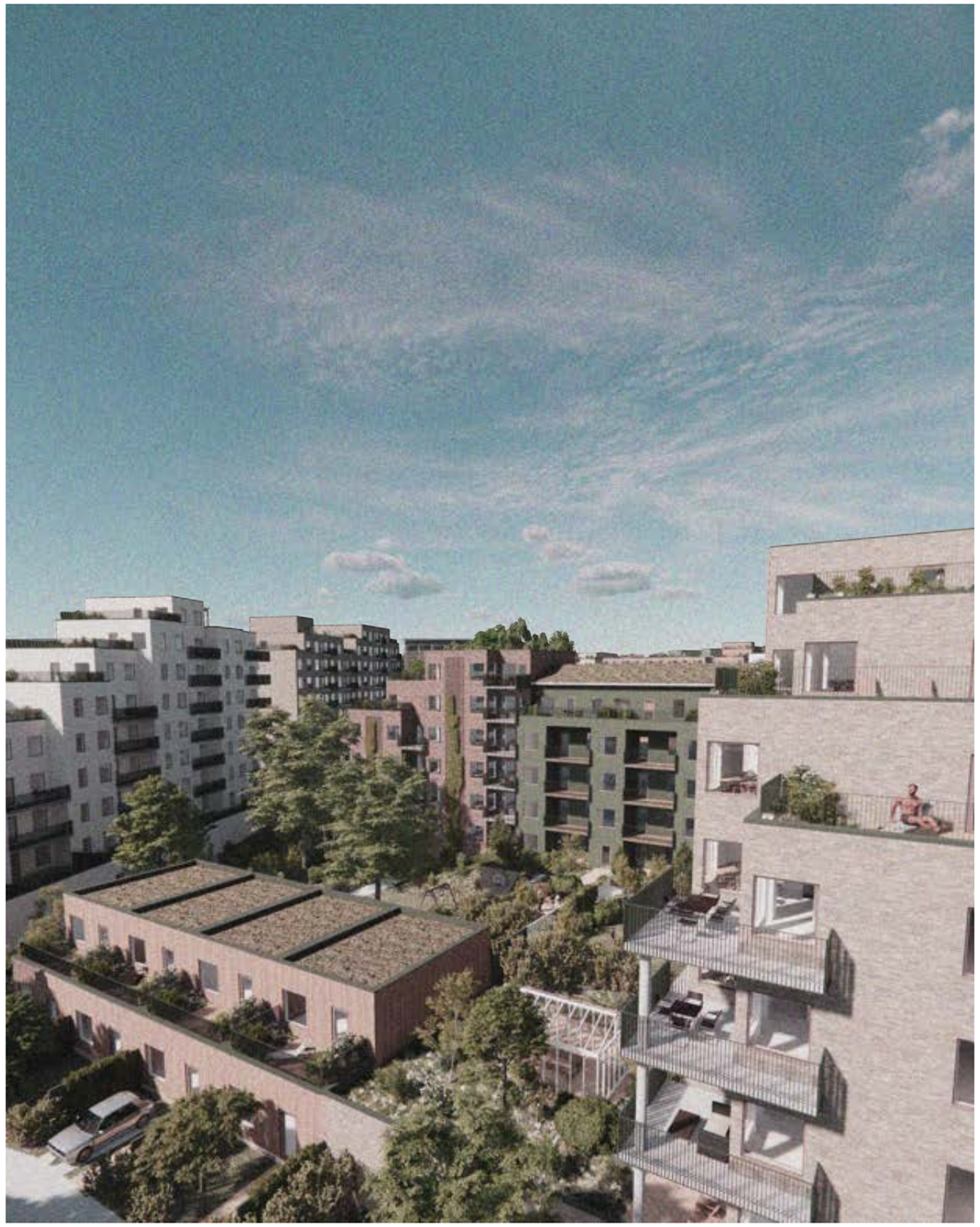
BUILDING LEVEL

CONNECT INDOORS AND OUTDOORS, VISUALLY AND PHYSICALLY

With awareness of the placement and size of windows and doors, nature is also made visible from inside the home and easily accessible.

SPACIOUS PRIVATE OUTDOOR AREAS

Private patios connected to the dwelling are the most used outdoor space. By providing homes with a spacious private patio, more activities can be carried out and generate residential qualities.



6 DESIGN

IMPLEMENTATION OF DESIGN STRATEGIES

The design proposal in this thesis is presented at several levels to be able to plan for ecosystem services and residential qualities in a holistic way. An urban plan is followed by a block plan and an example of a residential building. In this way the structural impact of planning can be presented as well as the details generating qualities on a human scale. For each level, implementation of design strategies are presented.

TYPOLOGY

The explorations showed that tall buildings with a small footprint are favourable from an ecosystem service perspective, while lower more widespread buildings are favourable from a residential qualities perspective. In the design proposal, these values need to be valued against each other. In addition to the fact that the design proposal in this thesis should combine ecosystem services and residential qualities, the proposal should also respond to Borås Stad's visions for the area. The goal is also to make the proposal relevant by not being too radical in the solutions. However, the ambition is for the proposal to surpass today's urban development's level of ecosystem services and residential qualities. Figure 55 shows what I hope the design proposal will position itself in these regards.

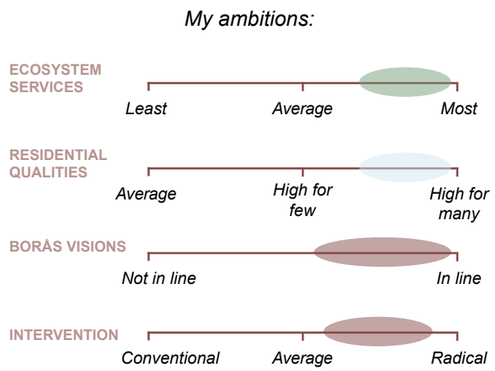
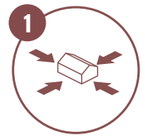


Figure 55. Priorities and objectives in the design from different aspects.

In order to combine ecosystem services with residential qualities, some compromises were needed to be made. This led me to combining the characteristics of different typologies. The design strategies 1 to 3 shaped the typology used in the design proposal.

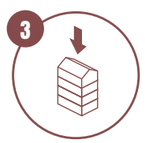


REDUCE BUILDING FOOTPRINTS AND IMPERMEABLE GROUND

The starting point is that the less ground that is used for buildings and as hard surfaces, the more ecosystem services can be produced. This would result in a tower-like typology.

DEFINE WHAT IS PRIVATE AND PUBLIC

However, there are challenges with high-rise development. Residential areas with the tower typology generally do not have defined courtyards that clearly distinguish between public and private. Nedre Norrby has a central location with potentially many people on the move in the area, especially given the proximity to the railway station. This makes it extra important to be able to separate the private spaces from the public. To counteract this, I prefer to use a block structure that encloses a courtyard.



REDUCE RESIDENTS DISTANCE TO GROUND

Another challenge with tall buildings is providing the residential qualities that proximity to the ground can offer. In the typology exploration, dwellings on the ground with a garden/large patio was able to offer the most residential qualities. Housing with roof terraces could also offer similar qualities. In a high density development, it is difficult to provide homes with their own gardens. However, the combination of a terraced and lower, more expansive development can provide a larger proportion of homes with garden-like outdoor environments next to their homes.

Typology for design proposal, based on design strategies 1-3, is found on the next page.

HYBRID TYPOLOGY

My interpretation of these three design strategies resulted in a typology that is a mix of the reference projects 79&Park and Bo01. The terracing is similar to 79&Park and allows the courtyard to open up to the southwest and let in sunlight to the courtyard, balconies and patios. I departed from a completely closed courtyard structure but was inspired by Bo01 to use a semi-open courtyard structure to create conditions for biological connectivity. Like Bo01, the different building volumes can also offer opportunities to mix up the apartment stock with, for example, townhouses. The partially open courtyard structure also makes the green courtyard environments visible in the streets and contributes to a green neighbourhood as a whole.

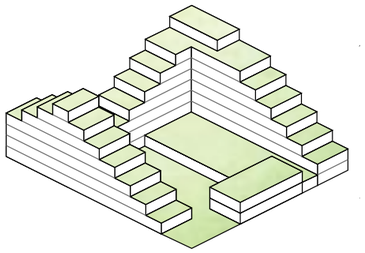


Fig 56. The hybrid typology used in the design proposal.

BLOCKS

The division of the land was based on the conclusions of the site analysis and Borås Stad's structure outline. From this, the main routes through the area, what natural areas and buildings should be saved and what land is suitable for new construction were defined.

Fig 57. The results from the site analysis and Borås structure outline.

Based on the division of the land, the buildable areas were divided into blocks of appropriate sizes. The aim was to create blocks with approximately 1200-2500 sqm of yard space. The division of the blocks was also based on desirable connections identified in the site analysis.

Fig 58. Dividing the land into blocks.

After this, the blocks were divided into separate buildings. This was done considering exisiting vegetation and creating green corridors through the neighbourhood and to every courtyard.

Fig 59. Dividing the blocks into buildings.

Throughout the process, I worked three-dimensionally to see how tall the buildings needed to be to accommodate the required amount of square metres.

BUILDINGS

An obvious challenge for the building designs in this thesis has been to find ways to bring up the vegetation vertically. Given the desired residential qualities, the challenge could be compared to stacking dwellings with residential qualities similar to a detached villa. The following principles and solutions have formed the basis for the building designs presented in the design proposal.

The terraced development typology partly solves the challenge of creating quality private outdoor spaces including nature for dwellings that are not on the ground floor. But it is difficult to create terraces for everyone when the buildings have many floors. It is possible to terrace the building in several directions, but this quickly results in a very deep building where you can have problems with daylight. To solve this, the first floors can be used as business premises or garages that do not have high daylight requirements.

Fig 60. White volumes symbolise dwellings with access to high-quality outdoor environments, such as ground-level patios or roof terraces. The brown volumes symbolise dwellings that can only have a balcony or similar. By terracing the building in several directions, a higher proportion of dwellings can have high-quality outdoor environments.

But there are also other ways to bring greenery and nature to floors far from the ground, without altering the building structure. For example, as Bosco Verticale, plantings can be placed on ledges on each floor, or climbing plants on trellises can make nature visible even far from the ground.

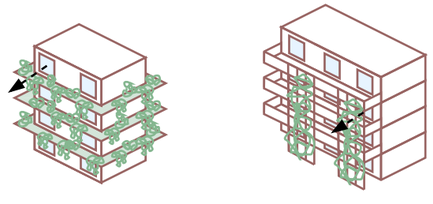


Fig 61. Ledges with vegetation and climbing plants on trellises makes nature visible on all floors in the building.

To create privacy for private outdoor spaces, the shape of the facade has an impact. By recessing and projecting the facade, private spaces can be created for private patios. The facades facing these spaces can also be opened up with windows or doors to connect different parts of the dwelling to the outdoor space. This generates more facade with contact to the outdoor environment. The facade of the dwelling can also be completely enclosed around an outdoor space like an atrium.

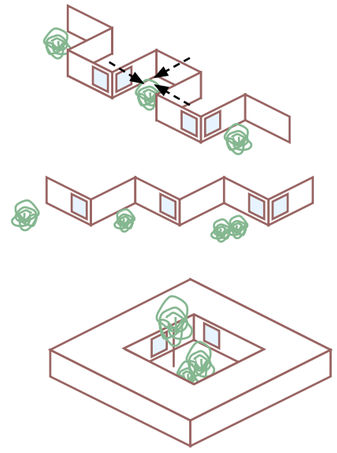


Fig 62. Principles of recessing and projecting of the facade and a atrium.

These principles are the main ones used in the building designs. Other types of interventions have also been used through out the site to accommodate and display the outdoor environment in a dense urban environment.

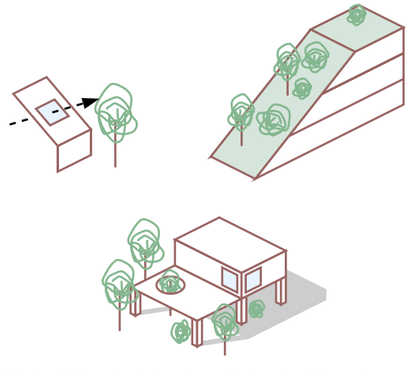


Fig 63. Skylights, slanted building that extend the outdoor environment onto roofs and elevated buildings that allow greenery to pass under buildings.

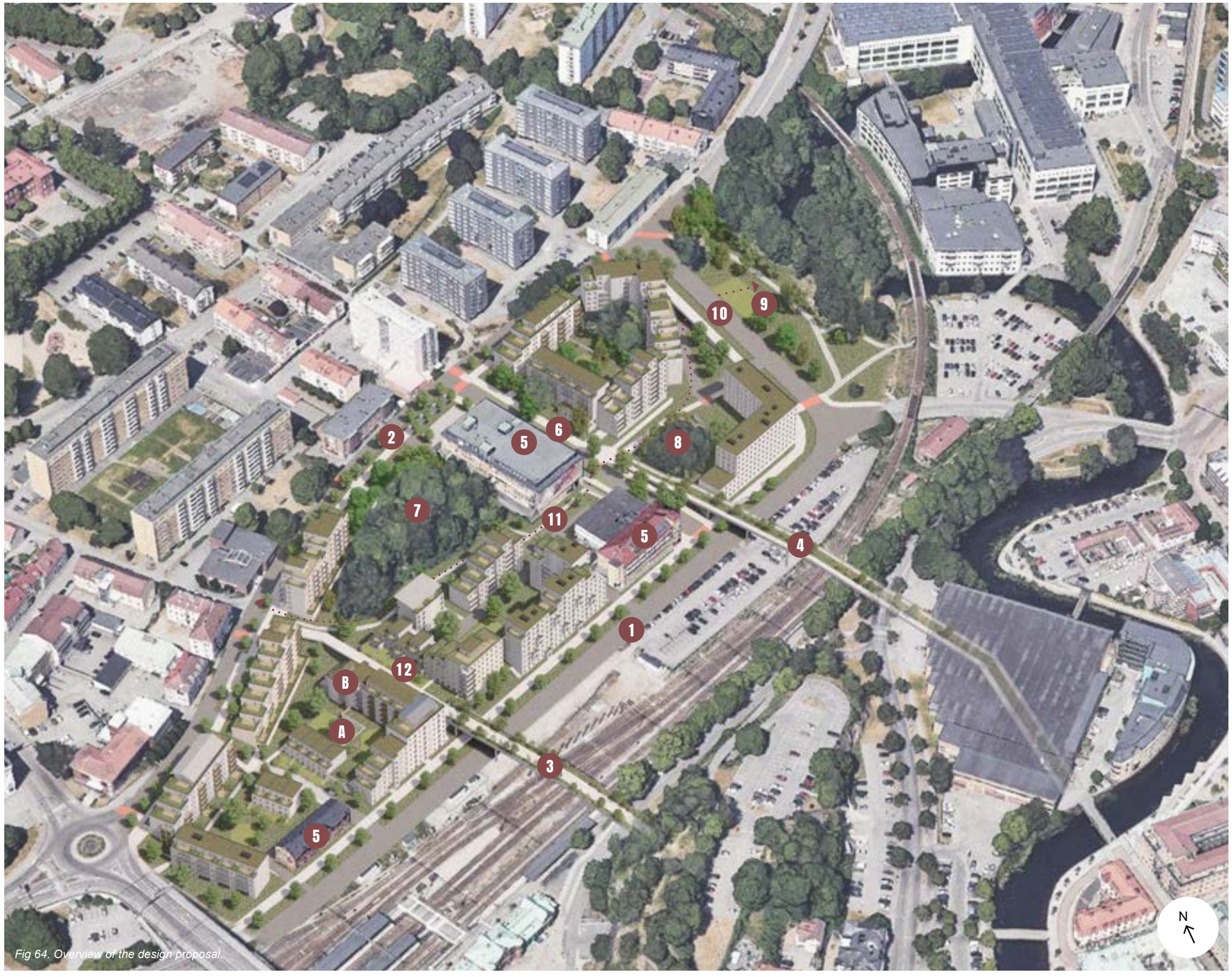


Fig 64. Overview of the design proposal.

Figure 64 illustrates an overview of the design proposal and the main interventions.

1. Magasinsgatan is moved eastwards closer to the railway tracks. It is widened to replace Norrby Långgata as the main road through the area and will handle the transport of dangerous goods. The street is lined with rain beds that manage rainwater from the street.

2. Norrby Långgata is made more narrow and have a reduced speed to minimise its barrier effect and make room for new buildings.

3. A new bridge over the railway tracks at Borås central to connect Norrby with the train station and the city centre via Krokhallsberget. The bridge serves as a green corridor to connect green areas.

4. A new bridge over the railway tracks at Norrby Tvärgata for Viskans Park that connects Norrby and the centre via Viskaholm. It also serves as a green corridor.

5. All buildings in the area, except for the warehouse at Gjutaren 8, are preserved. These buildings are used soley as business premises. These buildings are of high architectural quality and are important to preserve the memory of the site's former function as an industrial area.

6. Norrby Tvärgata serves as a hub for commercial activities. The majority of people moving between Norrby and the city centre will pass Norrby Tvärgata. The existing buildings are well suited for retail and office spaces. The new buildings along the street will have commercial premises on the ground floor.

7. The vegetation with shrubs and trees in the slope down from Norrby Långgata is kept and adapted to create a new park in the area.

8. The graffiti wall and adjacent vegetation will be preserved as a small park connected to the new bridge for Viskan Park.

Continues on the next page

9 The greenery along the Viskan river is the area's most valuable biotope and is saved to be used as a park. The park includes a large lawn for ball games and other activities, something that is in short supply in Norrby.

10 A bridge is used to manage the height difference when Magasinsgatan connects to Norrby Långgata. The bridge reduces the barrier effect of the new Magasinsgatan and allows people and animals to move between the park and the rest of Nedre Norrby without having to cross any roads. There is also space for car parkings under the bridge.

11 Through the Nedre Norrby site, a spine is created from north to south. Here, both people and animals can move in a calm and safe environment. This walk does not cross any residential courtyards and does not interfere with the private spaces.

12 A public parking garage for commuters is located under the bridge at Borås Central Station. The design proposal does not meet the Borås Stad's target of at least 300 public car parks in the area. This was one of the exceptions from the program.

A Location of the block presented in the design proposal.

B Location of the residential building presented in the design proposal.

DESIGN PROPOSAL FOR NEDRE NORRBY IN NUMBERS

AREA	75 000 sqm
EXPLOITABLE AREA	36 000 sqm
GFA	75 000 sqm
E-FACTOR	2,08
RESIDENTIAL GFA	60 000 sqm
BUSINESS GFA	15 000 sqm
NUMBER OF DWELLINGS (AVERAGE 85 SQM GFA PER DWELLING)	700
PARKING	Public parking lots in garage: 90 Public parking lots outside: 75

Fig 65. Design proposal for Nedre Norrby in numbers.

Roman numbers indicate number of floors. If just a Roman number is written on a building, the building is mainly a residential building. If it is written the letter B and a Roman number, that indicates that the building is solely for business use.

N

Exisiting buildings *New buildings* *Underground parking*
Private residential ground *Business premises on ground floor*

Fig 66. Plan of design proposal for Nedre Norrby. Scale 1:3000.

Fig 67. Section A-A. Scale 1:2000.

Fig 68. Roof terraces.

USE THE ROOFS

More or less every roof in the design proposal is a vegetated roof with a soil depth of at least 10 cm. This allows several types of plants to grow, which favours a variety of species and biodiversity. A thicker vegetated soil also contributes to a more efficient storm water delay and absorption. The green roofs also function as terraces and provide several residential qualities such as impressions of nature from inside the home and a place to enjoy outdoor activities in privacy.

MINIMIZE RESIDENTIAL YARDS ON CONSTRUCTIONS

The design proposal has sought to minimize yards on constructions and to ensure that no yards are completely on a floor. This allows vegetation to be long-lived, which favours biodiversity's continuity. Yards on the ground also allow plants to grow bigger and taller, contributing to greener and more nature-like outdoor environments.

Underground parking

Fig 69. Underground parking.

Fig 70. Green areas and green connections.

SAVE EXISTING VEGETATION

The majority of the existing natural areas and vegetation have been preserved in the design proposal to save the existing biodiversity of the site.

Existing vegetation.
Existing vegetation outside of Nedre Norrby.

CONNECT GREEN AREAS

The semi-open block structure makes ways for the spreading of plants and animal life. Streets with tree alleys and vegetated bridges/tunnels act as green connections between green areas.

Green corridors/connections

LARGER NATURAL GREEN AREAS ARE NEEDED FOR BIODIVERSITY

Existing greenery has been preserved to act as hubs for biodiversity that offers high-quliaty natural areas for animals and plants. These are for example the area along Viskan and the slope south of Norrby Långgata.

Fig 71. New bridge over Magasinsgatan and the railway tracks. The vegetation on the bridge helps connecting green areas.

ADAPT THE DESIGN TO THE AREA'S STORM WATER RUNOFF

In the design proposal, different types of waterways have been located throughout the site. These have been located based on the current storm water runoff structure of the site (Borås Stad, 2024). The waterways are designed as smaller channels or ditches, similar to Bo01. This makes water present throughout the area.

Ditches and waterways

USE STREETS FOR STORM WATER REGULATION AND PURIFICATION

The streets are provided with stormwater managing areas such as rain beds and ditches that delay and purifies storm water.

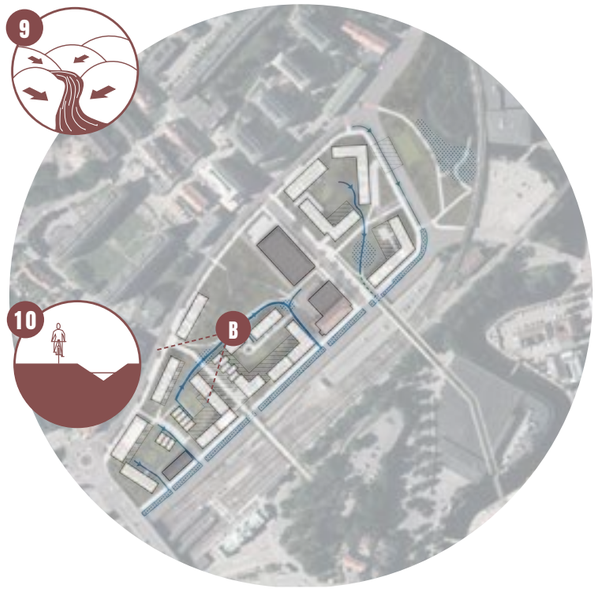


Fig 72. Rain beds, ditches and floodable surfaces.

PLAN FOR FLOODING

There are several places in the design proposal that can be flooded and retain rainwater during high water flows. These consist of both rain beds and vegetated spaces in parks. Rain beds can also act as flood plains.

Floodable surface/Rain beds

Fig 73. Storm water trench when flooded and in normal state.

BLOCK LEVEL

In order to show in detail what the living environments in the future Nedre Norrby could look like, an example of a block is presented. This block consists mostly of apartment buildings but also includes some town houses. The block is divided into several properties. In addition to the six town house properties, the block consists of five apartment house properties. The advantage of small properties is that the block can develop dynamically over time which favours a divers cityscape. A challenge with this, however, is that the outdoor environments tend to be fragmented. This may result in each individual part becoming less functional. To avoid this, a common property for a shared courtyard is proposed in this design. The shared courtyard/parking garage property could be managed through joint ownership between the neighbouring residents.

Fig 74. Location of the block.

THE BLOCK IN NUMBERS

AREA	5 000 sqm
GFA	12 000 sqm
NUMBER OF DWELLINGS	Apartments: 90 Town houses: 6
TYPE OF PRIVATE OUTDOOR SPACES	Terraces: 15 % Private patio: 19 % Balcony in one direction: 46 % Balcony in two directions: 12 %
SIZE OF YARD	Total yard area: 2900 sqm Courtyard area: 1700 sqm
PARKING	Residential parking lots in garage: 76 Residential parking lots outside: 4 Public parking lots outside: 15 Bicycle parking in garage: 300

Fig 75. The block in numbers.

— *Building contours* -·- *Property boarders* ▶ *Building entrance* ▷ *Second/Garage entrance* *Storm water trench*

Outdoor cooking *Outdoor seating* *Gardening* *Playing area* *Larger activity area*

1 1 1 *Plant selection is described by design strategy 18, page 75.*

Fig 76. Plan of the block. Scale 1:500.

Fig 77. Lawn that can be used for activities in the courtyard, surrounded by multilayer vegetation.

Fig 78. Vegetation on walls and big trees makes nature present on all floors in the buildings.

COMBINE WILD AND TAMED VEGETATION

The courtyards are planned to accommodate both activity areas such as paved surfaces and lawns. Other areas are proposed to grow wild with several layers of vegetation that can create a protected and varied environment. This contributes to biodiversity, absorbation of storm water and provides food and nests for pollinators.

VERTICALITY OF VEGETATION

To make greenery visually present even higher up in the buildings, vegetation on walls and big trees have been used in the design.

Fig 79. Section A-A. Scale 1:500.

LOW-INTENSITY MAINTENANCE ON GREEN AREAS

Green areas that are not used for activities are allowed to grow more or less freely. This allows more disturbance-sensitive plants and animals to establish themselves. Leaving dead tree trunks and branches also provides habitats for insects and pollinators.

MULTIPLE LAYERS OF VEGETATION

The courtyards have both trees, bushes and ground-covering plants to imitate a natural environment. This provides multiple ecosystem services and different types of habitats.

Fig 80. Low-intensity managed multi layered vegetation.

Fig 81. Separated outdoor rooms.

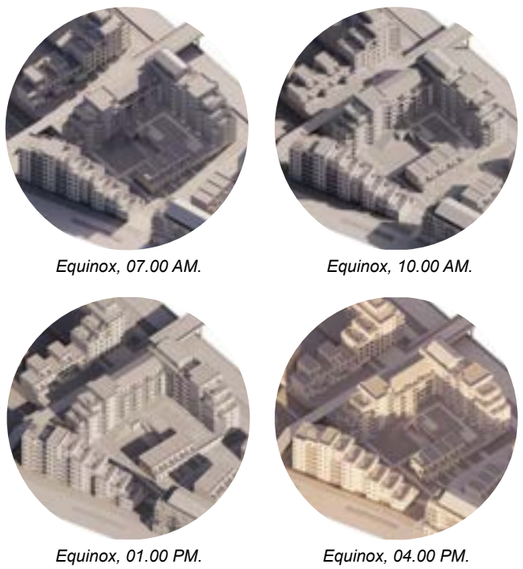
OUTDOOR PRIVACY

Rooms

To make the courtyards usable for many residents at the same time, vegetation, height differences, walls and different ground materials, are used to shape multiple outdoor rooms.

YARDS OF SUFFICENT SIZE

To provide good solar conditions for courtyards and patios, the courtyard structure has been opened up to the south-west. The terracing of the buildings also helps to create good conditions for sun in the courtyard and patios. Balconies and patios generally face south-west to give them hours of sunshine in the afternoons. Yards have an average size of 1500 sqm to make space for several activities and different enviorments.



Equinox, 07.00 AM. *Equinox, 10.00 AM.*

Equinox, 01.00 PM. *Equinox, 04.00 PM.*

Fig 82. Access to sunlight in the block throughout the day.

USE SPONTANEOUS VEGETATION AND LOCAL SPECIES

The vegetation in the design proposal is based on local plants identified in the inventory or from literature. Below, examples of plants used in the design proposal are presented. These plants particularly contribute to biodiversity and food for pollinators. Berries, fruits and a variety of plants with different flowering times are important assets.

TREES

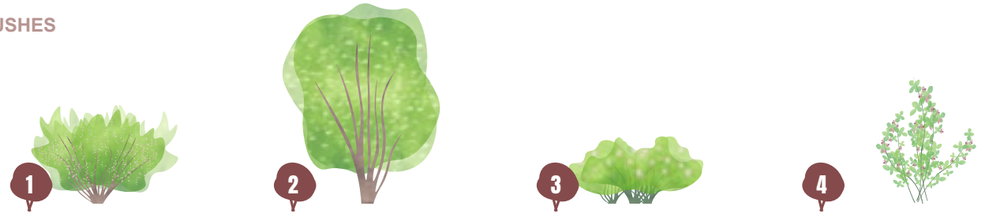
Goat Willow (Sälg)
Salix caprea
Flowering period: Mars-April
Grows on site today: No

Linden (Lind)
Tilia cordata
Flowering period: June-August
Grows on site today: Yes

Wild Cherry (Fågelbär)
Prunus avium
Flowering period: April-May
Grows on site today: No

Aspen (Asp)
Populus tremula
Flowering period: Mars-April
Grows on site today: Yes

BUSHES



Red currant (Vinbär)
Ribes rubrum
Flowering period: April-May
Grows on site today: No

Elderflower (Fläder)
Sambucus nigra
Flowering period: May-June
Grows on site today: No

Dog rose (Nyponros)
Rosa dumalis
Flowering period: June-July
Grows on site today: Yes

Blackberry (Björnbär)
Rubus
Flowering period: June-August
Grows on site today: Yes

FLOWERS

Vetch (Vicker)
Vicia
Flowering period: May-September
Grows on site today: Yes

Daisy (Prästkrage)
Leucanthemum vulgare
Flowering period: June-July
Grows on site today: Yes

Black Knapweed (Svartklint)
Centaurea nigra
Flowering period: July-August
Grows on site today: Yes

Birdsfoot Trefoil (Kärringtand)
Lotus corniculatus
Flowering period: June-July
Grows on site today: Yes

Fig 83. Examples of plants used in the design. Trees and bushes have been selected from recommendations by Hansson (2022) and flowers recommended by Naturskyddsföreningen (2022).

The aim of the building design has been to maximise the residential qualities from the outdoor environment. The types of housing that proved to have the most living qualities linked to the outdoor environment in the exploration were homes with their own patios/gardens or terraces. Therefore, the building design aims to provide a high proportion of these types of dwellings. However, this is a challenge at high development. This building fits 16 apartments, of which 5 apartments (31%) have either a patio or terrace. To create the most residential qualities for apartments that only have balconies, the balconies have been made large to accommodate more activities. Windows and doors from several rooms towards the balcony also help to connect the activities on the balcony to a larger part of the dwelling.

Fig 84. Location of residential building.

Fig 85. Exterior of residential building.

THE BUILDING IN NUMBERS

DWELLINGS

1 room apartment:	1
2 room apartment:	10
3 room apartment:	3
4 room apartment:	2

TYPE OF PRIVATE OUTDOOR SPACES

Terraces:	3 (19%)
Private patio:	2 (12%)
Balcony on the corner:	3 (19%)
Balcony in one direction:	8 (50)

Fig 86. The building in numbers.

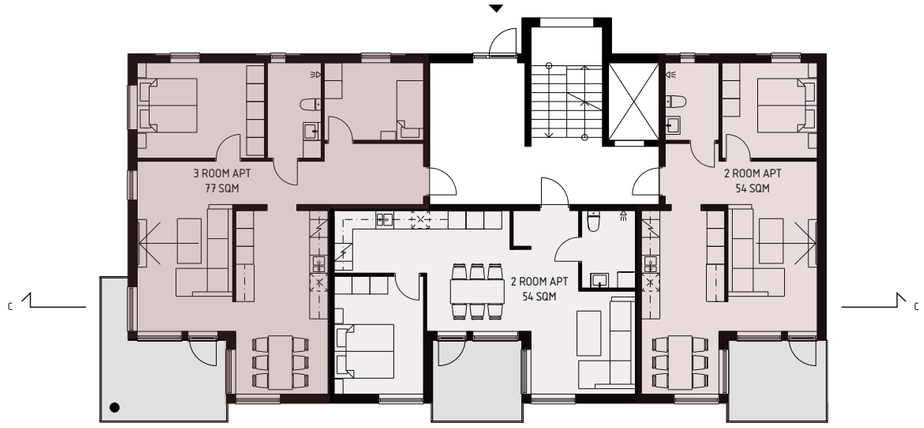


Fig 87. Floor plan ground floor. Scale 1:200.

Fig 88. Floor plan of 6th floor with terrace. Scale 1:200.

CONNECT INDOORS AND OUTDOORS,
VISUALLY AND PHYSICALLY

19

With awareness of the placement and size of windows and doors, nature is also made visible from inside the home and easily accessible. Here are examples of how the interface with the outdoor environment for an apartment can be designed. The selected apartment has a terrace and is located on the sixth floor (floorplan in fig 88).

By placing the stairwell along the facade, the greenery outside becomes visible in the staircase.

From the entrance of the apartment, the greenery on the roof terrace and the courtyard are visible.

Through the living room windows, the shrubs and plants on the roof terrace are visible.

Both the greenery on the courtyard and the terrace are visible from the kitchen windows.

Fig 89. Examples of views of greenery from inside the dwellings.

SPACIOUS PRIVATE OUTDOOR AREAS

20

All the apartments in the building have spacious private patios for socialising within the household for a meal, growing vegetables or just watching the sunset. Recessed into the facade, the outdoor spaces have a private character. A small protruding part of the balconies allows you to get outside the niche in the facade to enjoy more hours of sunshine.

BALCONY

Size: 8 sqm
For 2 room apartments.

BALCONY

Size: 13,5 sqm
For 3 room apartments.

TERRACE

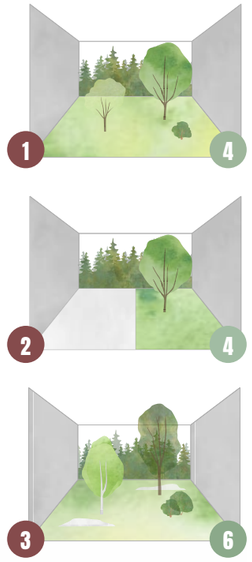
Size: 49 sqm
(Wooden deck 14 sqm)
For 4 room apartments.

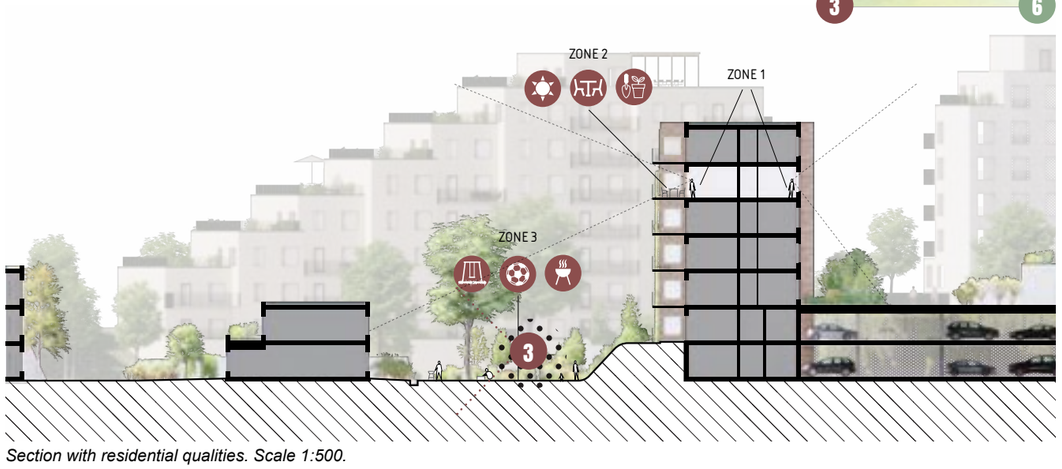
Fig 90. Examples of private outdoor areas in the residential building.

RESIDENTIAL QUALITIES MAPPING

Floorplan floor 6. Scale 1:200.

IMPRESSIONS OF NATURE





Section with residential qualities. Scale 1:500.

RESIDENTIAL QUALITIES - BY ZONES

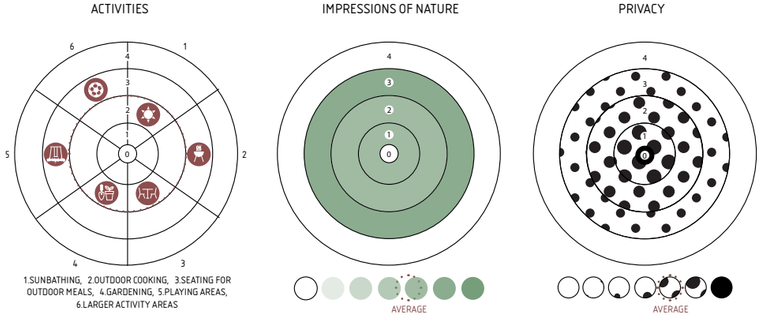


Fig 91. Residential qualities for a characteristic dwelling in the residential building.

BIOTOPE AREA FACTOR

		Surfaces	Amount	Unit
	S0	Hard surfaces	39440	sqm
1	S1/2	Preserved important habitat	3330	sqm
2	S1/2	Preserved nature	5000	sqm
	S1/2	Forest	900	sqm
	S1/2	Bushes	4000	sqm
	S1/2	Rain beds/Ditch	2400	sqm
	S1/2	Plantings/Cultivation	4800	sqm
	S1/2	Lawn	3100	sqm
	S1/2	Meadow	9100	sqm
	S1/2	Big tree	80	pieces
	S1/2	Smaller tree/Big plant	114	pieces
	S2/3	Smaller tree in skeletal soil	0	pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction	6600	sqm
	S2/3	Sedum on construction	3900	sqm
	S2/3	Lawns on construction	400	sqm
	S2/3	Climbing vegetation	2000	sqm
	S4	Water	360	sqm
	S4	Wetlands		sqm

BIOTOPE AREA FACTOR ON SITE TODAY

GYF-quota:	**0,68**

BIOTOPE AREA FACTOR DESIGN PROPOSAL

Total area:	**75000**	**sqm**	
Total points surfaces:	48928	37	%
Total points qualities:	81678	63	%
TOTAL (eco efficent area)	**130606**		
GYF-quota:		**1,74**	

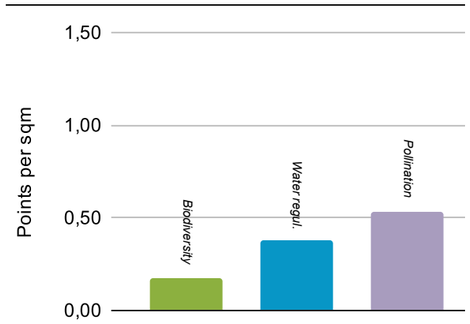
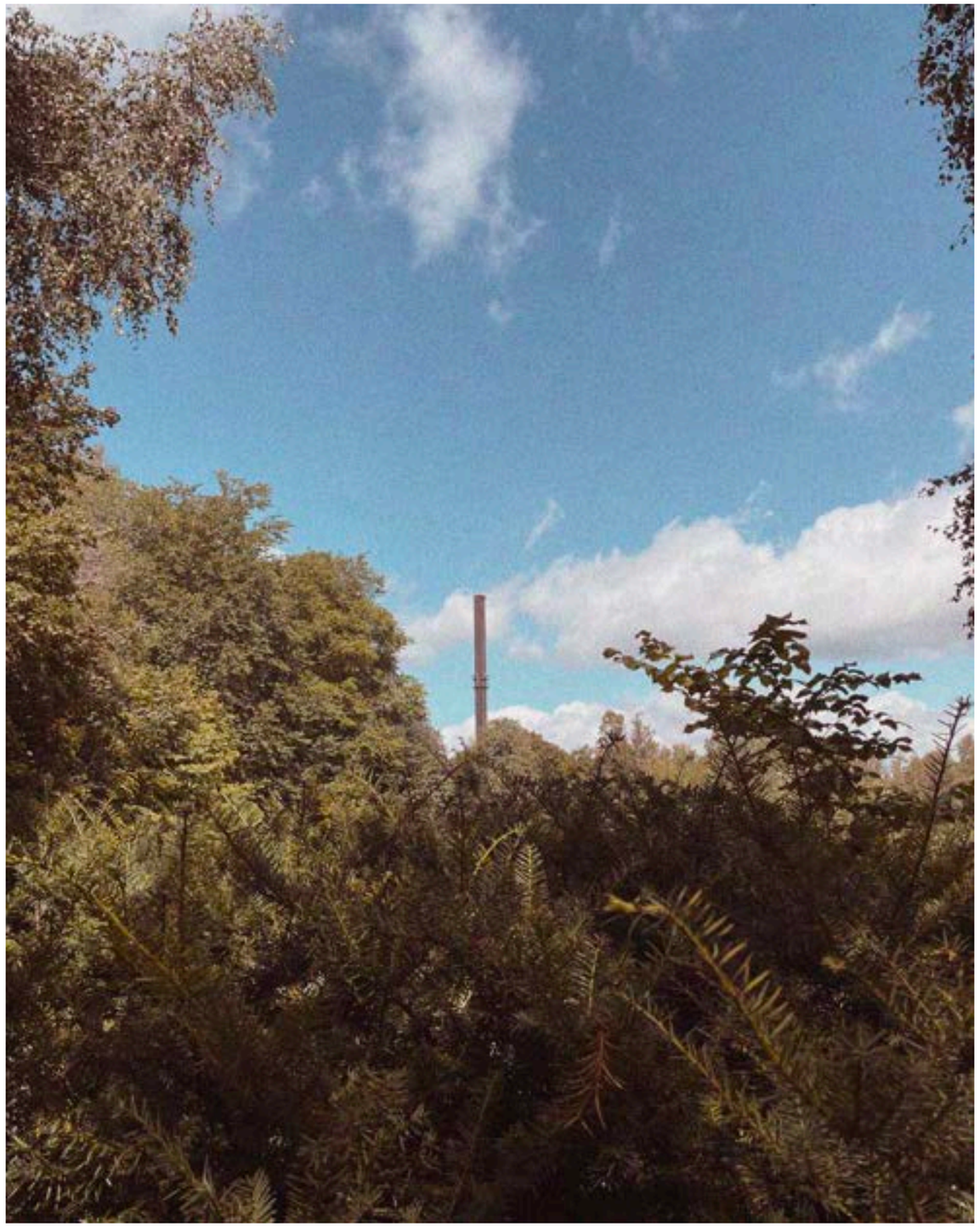


Fig 92. Calculation of biotope area factor for the design proposal. The full calculation can be found in the appendix.



7 DISCUSSION AND CONCLUSION

DISCUSSION

To answer the thesis question "*How can ecosystem services and residential qualities work together in the transformation of the Nedre Norrby site in Borås?*", this thesis developed an adapted use of the biotope area factor tool GYF 3.0 and mapping tools for residential qualities to carry out explorations. From the explorations and initial reseach, twenty design strategies that either benefit the selected ecosystem services, residential qualities or both of them were concluded. The design strategies resulted in a design proposal consisting of semi-open blocks of terraced buildings with spacious residential courtyards with private character. The strategies found to benefit both ecosystem services and residential qualities were the use of green roofs with terraces, providing yards of sufficient size and minimizing yards on floors.

This thesis shows that a brownfield like Nedre Norrby could be transformed as part of a densification strategy and at the same time strengthen the selected ecosystem services and provide quality residential environments. However, this is largely based on the fact that large parts of Nedre Norrby today consist of paved car parks. If the development had taken place in an area containing a larger proportion of green spaces, the result would probably not have been as positive for ecosystem services.

The design proposal corresponds to Borås Stad's visions for Nedre Norrby, like fitting 75 000 sqm GFA of mixed-used buildings and new connections between Norrby and the city centre. The only exceptions are that a little more land is used towards the railway station and that the plan does not accommodate as many public car parks as requested. The parking spaces could possibly be accommodated in the vicinity of the train station on another property that is planned to be transformed within the framework of the structure outline for the western city centre.

The proposal brings together the benefits that nature provides both to functioning ecosystems and to humans. In some cases, the same strategy can favour both aspects, while in other cases, it requires action separately. For example, Persson & Smith (2014) describe connectivity and matrix (quality of green spaces, partly related to the sizes of green spaces) as fundamental conditions for biodiversity, while Minoura (2019) and Forshed & Nylander (2003) emphasise the importance of privacy in and around the dwelling. This meant that the design needed to both create separations between outdoor environments such as different courtyards and between different patios, but also contain openings/connections between green spaces so that they can form a coherent ecosystem. The use of green roofs with terraces, on the other hand, favours both residential qualities and all three studied ecosystem services. Roof terraces allows performing outdoor activities adjacent to the dwelling, a quality presented by Kristensson (2007). The roof terraces also make nature visible from inside the dwelling, according to Kellert's and Calabrese's biophilic design framework (2015).

In some cases, it is not clear if the strategies favour both ecosystem services and residential qualities. Wild grown environments with low-intensity management are favourable from an ecosystem service perspective (Persson & Smith, 2014). They can also be beneficial for the residential qualitiy impression of nature (Kellert & Calabrese, 2015), related to direct experience of the element 'Natural landscapes and ecosystems'. However, there are also people who find these environments unpleasant (Gunnarsson, 2023). The design proposal therefore includes both wild grown environments and more managed environments to meet different types of needs and preferences.

This thesis shows that to benefit both ecosystem services and residential qualities from the outdoor environment, there is a need to work at multiple levels. Many of the strategies that promote ecosystem services have to be considered on a large area to function, while many residential qualities need to be considered on a more detalied level, like for a building.

When comparing my design proposal with residential projects that have specifically worked to promote ecosystem services, there are both similarities and differences in the architectural outcome. Taking Brf Viva as an example, the preservation of the existing vegetation, connectivity between green spaces and the use of local species have also been used as strategies in the project to favour ecosystem services (Riksbyggen, 2017). However, in Brf Viva, the residential qualities have been focused on social interaction between residents. This is done by creating spaces and outdoor environments in the complex that promote interaction between neighbours. Privacy has not been a defining residential quality and is therefore something that is lacking in the project. The use of galleries in the project results in a risk of being observed in your apartment by neighbours. In my work, the definition of residential qualities resulted in the importance of privacy, which also characterised the design proposal.

The working method of evaluating components and typologies, enables finding design strategies that favours ecosystem services and residential qualities in an early stage of the design process. Depending on the desired outcomes of the project, the assessment criterias can be customised.

Several simplifications of the biotope area factor-tool were made in order for me as an architecture student to do the calculations. For example, creating a general scoring of surfaces and leaving out some point objects. Landscape context was also excluded in the calculations since it didn't apply to the component explorations that were calculated without context to make the results comparable. Landscape context was however considered in other stages of the work, like in the site analysis and in the design proposal. Had this work been carried out in collaboration with a landscape architect, ecologist, biologist or someone with similar expertise, more qualities in the GYF 3.0 could have been calculated. More detailed inventory data could also have helped in this regard. This could have affected the outcome of the explorations and the design proposal. In particular, the nuances between the different components of the explorations would probably have become clearer. More precise objectives based on biotopes on the site/requested biotopes by expertise could also have made explorations even more relevant based on the site's conditions.

The economic aspects in terms of investment costs and need of maintenance have not been in focus in this thesis. However, the ambitions has been that outdoor environments should be easy to maintain and buildings should not be too complicated to build. Investigating the exact economic implications of an increased use of nature in residential areas to create ecosystem services and residential qualities would be an important next step in realising the ideas from this thesis. The economic benefits that ecosystem services contribute would then also need to be taken into account and could justify higher initial investment costs.

This also touches on the relationship that residents have with these natural environments. Could these environments be maintained to a large extent by the residents, or do they need to hire staff for maintenance work? In the design proposal, I have assumed that the residential yard and green roofs are managed by the landlord/housing association, while roof terraces could either be managed by the residents based on simpler instructions, like what plants that should grow on the terraces and how they should be maintained. Landlords or housing associations could possibly also handle the maintenance of the terraces, like in Bosco Verticale. The vegetation on the terraces are included in the calculations of the biotope area factor as a part of the production of ecosystem services. I have not included any ecosystem services from balconies or patios in the calculations. This was mainly so that residents' involvement are not generally required. If further research had been conducted into the relationship between the production of ecosystem services and resident involvement, it might be possible to find favourable arrangements for keeping maintenance costs down by involving residents which could also give residents other values in return. For example, being able to grow their own food or produce other raw materials.

CONCLUSIONS

The design proposal for Nedre Norrby shows that the selected ecosystem services and residential qualities can work together in a transformation.

To answer the thesis question, the biotope area factor tool GYF 3.0 was used and modified to be more manageable for an architect to evaluate ecosystem services in the design process. Evaluation tools to map residential qualities related to the outdoor environment were also created by evaluating the possibility for residents to carry out outdoor activities, the degree of privacy and access to impressions of nature in the living environment. These residential qualities have been assessed from the perspective that the closer to the dwelling these qualities are, the better.

Based on these tools, explorations could be carried out. This, together with the initial research, resulted in 20 design strategies that were applied to a design proposal for Nedre Norrby. The design proposal ranges from an urban plan for the area down to the design of a residential building.

The design strategies resulted in a design consisting of semi-open blocks of terraced buildings with spacious residential courtyards. The proposal links Norrby with the city centre both mentally and physically and brings Borås closer to the vision of a green and vibrant city.

This thesis aimed to bring understanding, for me and the reader, what role nature in urban environments plays. Both to humans and ecosystems, and how the design process for an architect can be organised to evaluate design choices.

Future research could have further explored the economic risks and opportunities of urban development with more nature, and the relationship between residents and nature in these projects. Closer collaboration with a biologist, ecologist, landscape architect or similar, with greater knowledge of ecosystem services, could have deepened the knowledge about the work with ecosystem services.

Hopefully, this thesis and this way of working can be an inspiration for creating greener urban environments. By prioritising ecosystem services and residential qualities in urban development, architects could help making cities more sustainable, both for people and nature.

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CHALMERS
UNIVERSITY OF TECHNOLOGY

2024
Getting to know nature
Carl Rajala Pettersson

Chalmers University of Technology
Department of Architecture and Civil Engineering
Architecture and Planning Beyond Sustainability
Building Design and Transformation for Sustainability

Examiner: Liane Thuvander
Supervisor: Peter Elfstrand

APPENDIX

INCLUDES CALCULATION OF BIOTOPE AREA FACTOR

2024
Getting to know nature
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Chalmers University of Technology
Department of Architecture and Civil Engineering
Architecture and Planning Beyond Sustainability
Building Design and Transformation for Sustainability

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BIOTOPE AREA FACTOR - TODAY & NEW DESIGN

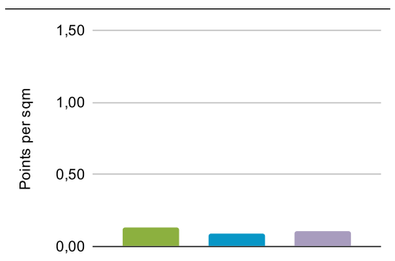
SITE TODAY

Total area:	**75000**	**sqm**	
Total points surfaces:	26693	53	%
Total points qualities:	24082	47	%
TOTAL (eco efficent area)	**50775**		
GYF-quota:		**0,68**	

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	61540	sqm
1	S1/2	Preserved important habitat	3330	sqm
2	S1/2	Preserved nature	9350	sqm
	S1/2	Forrest	900	sqm
	S1/2	Bushes	350	sqm
	S1/2	Rain beds/Ditch	0	sqm
	S1/2	Plantings/Cultivation	110	sqm
	S1/2	Lawn	7900	sqm
	S1/2	Meadow	4200	sqm
	S1/2	Big tree	18	pieces
	S1/2	Smaller tree/Big plant	59	pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction		sqm
	S2/3	Sedum on construction		sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Green and blue surfaces	Area (m2)		Points
Green and blue surfaces	26693	0	26693

	Quality	Area (m2)	Factor	Points
Q2	Preserved important habitat outside of landscape context	3330	0,8	2664
Q4	Preserved other nature outside of landscape context	9350	0,6	5610
Q7	Newly created important habitat outside of landscape context	450	0,4	180
Q9	Newly created other nature outside of landscape context	5663	0,2	1133
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	13460	0,5	6730
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	0	0,5	0
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	4310	1,3	5603
Q30	Pollinator-friendly surface	2703	0,8	2162
	Total:	**39266**		**24082**



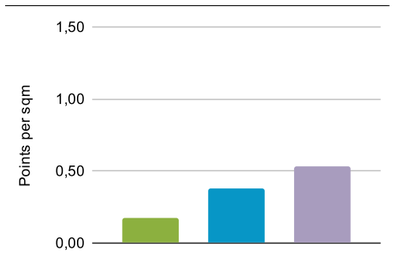
	Balance	Points	%	per sqm
	Biodiversity	9587	5	0,13
	Water purification and regulation	6730	28	0,09
	Pollination	7765	32	0,10

DESIGN PROPOSAL

	Total area:	**75000**	**sqm**	
	Total points surfaces:	48928	37	%
	Total points qualities:	81678	63	%
	TOTAL (eco efficent area)	**130606**		
	GYF-quota:		**1,74**	

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	39440	sqm
1	S1/2	Preserved important habitat	3330	sqm
2	S1/2	Preserved nature	5000	sqm
	S1/2	Forrest	900	sqm
	S1/2	Bushes	4000	sqm
	S1/2	Rain beds/Ditch	2400	sqm
	S1/2	Plantings/Cultivation	4800	sqm
	S1/2	Lawn	3100	sqm
	S1/2	Meadow	9100	sqm
	S1/2	Big tree	80	pieces
	S1/2	Smaller tree/Big plant	114	pieces
	S2/3	Smaller tree in skeletal soil	0	pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction	6600	sqm
	S2/3	Sedum on construction	3900	sqm
	S2/3	Lawns on construction	400	sqm
	S2/3	Climbing vegetation	2000	sqm
	S4	Water	360	sqm
	S4	Wetlands		sqm

	Green and blue surfaces	Area (m2)		Points
	Green and blue surfaces	48928	0	48928
	Quality	**Area (m2)**	**Factor**	**Points**
Q2	Preserved important habitat outside of landscape context	3330	0,8	2664
Q4	Preserved other nature outside of landscape context	5000	0,6	3000
Q7	Newly created important habitat outside of landscape context	2360	0,4	944
Q9	Newly created other nature outside of landscape context	33738	0,2	6748
Q18	Watercourses used for the treatment and retention of stormwater	360	0,7	252
Q19	Permeable vegetation-covered natural surface	24300	0,5	12150
Q20	Vegetated temporary floodplain	2400	0,5	1200
Q21	Areas specifically designed for the treatment and retention of stormwater	29680	0,5	14840
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	20500	1,3	26650
Q30	Pollinator-friendly surface	16538	0,8	13230
	Total:	**138206**		**81678**



	Balance	Points	%	per sqm
	Biodiversity	13356	9	0,18
	Water purification and regulation	28442	35	0,38
	Pollination	39880	49	0,53

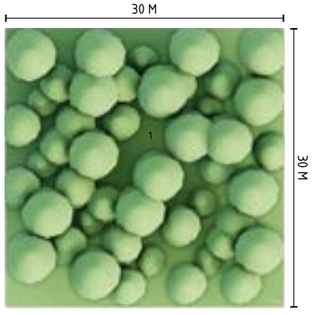
COMPONENTS EXPLORATIONS

NATURE/PARK

NATURE/PARK 1

Reference: Forrest Nedre Norrby

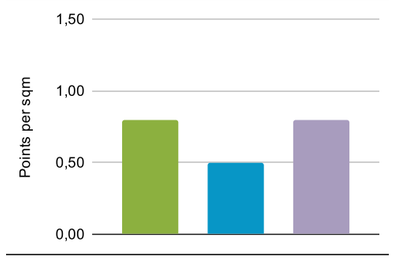
Example of deciduous forrest on the site today.



Total area:	**900**	**sqm**
Total points surfaces:	900	32 %
Total points qualities:	1890	68 %
TOTAL (eco efficent area)	**2790**	
GYF-quota:		**3,10**

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	0	sqm
1	S1/2	Preserved important habitat	900	sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest	900	sqm
	S1/2	Bushes		sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation		sqm
	S1/2	Lawn		sqm
	S1/2	Meadow		sqm
	S1/2	Big tree		pieces
	S1/2	Smaller tree/Big plant		pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction		sqm
	S2/3	Sedum on construction		sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

	Green and blue surfaces	Area (m2)		Points
	Green and blue surfaces	900	0	900
	Quality	**Area (m2)**	**Factor**	**Points**
Q2	Preserved important habitat outside of landscape context	900	0,8	720
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	0	0,2	0
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	900	0,5	450
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	0	0,5	0
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	0	1,3	0
Q30	Pollinator-friendly surface	900	0,8	720
	Total:	**2700**		**1890**

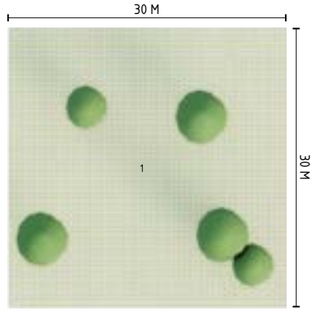


Balance	Points	%	per sqm
Biodiversity	720	0	0,80
Water purification and regulation	450	24	0,50
Pollination	720	38	0,80

NATURE/PARK 2

Reference: Meadow Nedre Norrby

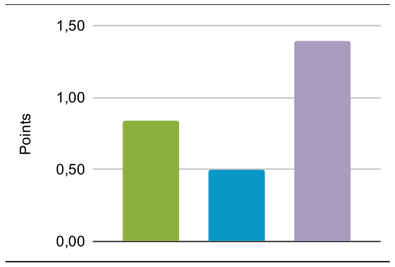
Ruderal land with meadow character on the site today.



Total area:	**900**	**sqm**
Total points surfaces:	1009	29 %
Total points qualities:	2464	71 %
TOTAL (eco efficent area)	**3473**	
GYF-quota:		**3,86**

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	0	sqm
1	S1/2	Preserved important habitat	900	sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest		sqm
	S1/2	Bushes		sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation		sqm
	S1/2	Lawn		sqm
	S1/2	Meadow	900	sqm
	S1/2	Big tree	3	pieces
	S1/2	Smaller tree/Big plant	2	pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction		sqm
	S2/3	Sedum on construction		sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

	Green and blue surfaces	Area (m2)		Points
	Green and blue surfaces	1009	0	1009
	Quality	**Area (m2)**	**Factor**	**Points**
Q2	Preserved important habitat outside of landscape context	900	0,8	720
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	75	0,4	30
Q9	Newly created other nature outside of landscape context	34	0,2	7
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	900	0,5	450
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	0	0,5	0
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	900	1,3	1170
Q30	Pollinator-friendly surface	109	0,8	87
	Total:	**2918**		**2464**

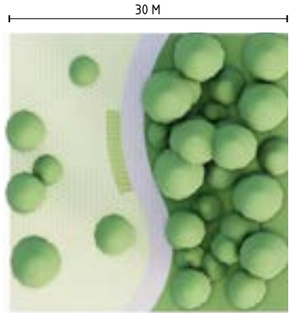


Balance	Points	%	per sqm
Biodiversity	757	1	0,84
Water purification and regulation	450	18	0,50
Pollination	1257	51	1,40

NATURE/PARK 3

Reference: Stadsparken, Borås

The city park in Borås. English garden style.



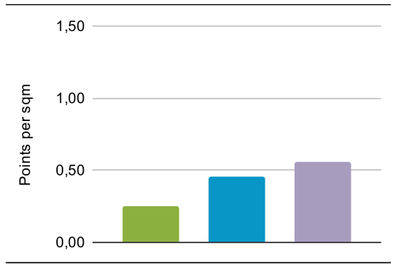
Total area:	**900**	**sqm**
Total points surfaces:	1005	47 %
Total points qualities:	1144	53 %
TOTAL (eco efficent area)	**2149**	

GYF-quota:		**2,39**

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	80	sqm
1	S1/2	Preserved important habitat		sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest	423	sqm
	S1/2	Bushes		sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation	14	sqm
	S1/2	Lawn	383	sqm
	S1/2	Meadow		sqm
	S1/2	Big tree	4	pieces
	S1/2	Smaller tree/Big plant	5	pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction		sqm
	S2/3	Sedum on construction		sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Green and blue surfaces	Area (m2)		Points
Green and blue surfaces	1005	0	1005

Quality		Area (m2)	Factor	Points
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	523	0,4	209
Q9	Newly created other nature outside of landscape context	99	0,2	20
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	820	0,5	410
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	0	0,5	0
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	14	1,3	18
Q30	Pollinator-friendly surface	608	0,8	486
	Total:	**2064**		**1144**

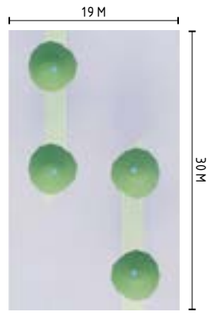


Balance	Points	%	per sqm
Biodiversity	229	20	0,25
Water purification and regulation	410	36	0,46
Pollination	505	44	0,56

STREET 1

Reference: Yxhammargatan, Borås

Typical urban street of Borås, with rows of trees, parking pockets and patches of grass.



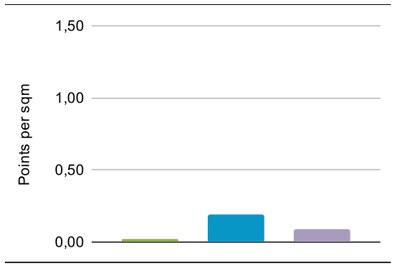
Total area:	**590**	**sqm**
Total points surfaces:	158	47 %
Total points qualities:	181	53 %
TOTAL (eco efficent area)	**339**	

GYF-quota:		**0,57**

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	500	sqm
1	S1/2	Preserved important habitat		sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest		sqm
	S1/2	Bushes		sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation		sqm
	S1/2	Lawn	90	sqm
	S1/2	Meadow		sqm
	S1/2	Big tree		pieces
	S1/2	Smaller tree/Big plant		pieces
	S2/3	Smaller tree in skeletal soil	4	pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction		sqm
	S2/3	Sedum on construction		sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Green and blue surfaces	Area (m2)		Points
Green and blue surfaces	158	0	158

Quality		Area (m2)	Factor	Points
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	68	0,2	14
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	90	0,5	45
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	0	0,5	0
Q22	Stormwater managing trees in impermable surfaces	68	1	68
Q29	Pollinator node	0	1,3	0
Q30	Pollinator-friendly surface	68	0,8	54
	Total:	**294**		**181**

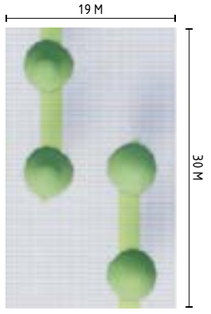


Balance	Points	%	per sqm
Biodiversity	14	8	0,02
Water purification and regulation	113	62	0,19
Pollination	54	30	0,09

STREET 2

Reference: Strandbodgatan, Uppsala

Urban street with rain gardens to handle water regulation and purification. The street includes avenues of trees and parking pockets.

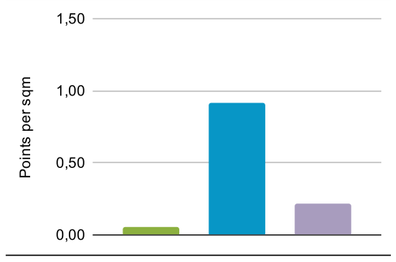


Total area:	**590**	**sqm**
Total points surfaces:	158	18 %
Total points qualities:	698	82 %
TOTAL (eco efficent area)	**856**	

GYF-quota:		**1,45**

Symbol		Surfaces	Amount	Unit
	S0	**Hard surfaces**	500	sqm
1	**S1/2**	**Preserved important habitat**		sqm
2	**S1/2**	**Preserved nature**		sqm
	S1/2	**Forrest**		sqm
	S1/2	**Bushes**		sqm
	S1/2	**Rain beds/Ditch**	90	sqm
	S1/2	**Plantings/Cultivation**		sqm
	S1/2	**Lawn**		sqm
	S1/2	**Meadow**		sqm
	S1/2	**Big tree**		pieces
	S1/2	**Smaller tree/Big plant**	4	pieces
	S2/3	**Smaller tree in skeletal soil**		pieces
	S2/3	**Plantings/Cultivation/Bushes/Meadow on construction**		sqm
	S2/3	**Sedum on construction**		sqm
	S2/3	**Lawns on construction**		sqm
	S2/3	**Climbing vegetation**		sqm
	S4	**Water**		sqm
	S4	**Wetlands**		sqm

	Green and blue surfaces	**Area (m2)**		**Points**
	Green and blue surfaces	158	0	158
	Quality	**Area (m2)**	**Factor**	**Points**
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	158	0,2	32
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	90	0,5	45
Q20	Vegetated temporary floodplain	90	0,5	45
Q21	Areas specifically designed for the treatment and retention of stormwater	900	0,5	450
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	0	1,3	0
Q30	Pollinator-friendly surface	158	0,8	126
	Total:	**1396**		**698**

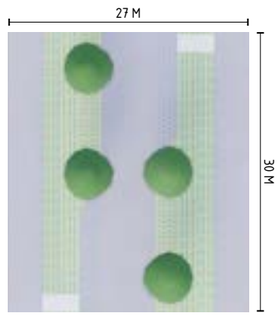


	Balance	Points	%	per sqm
	Biodiversity	32	5	0,05
	Water purification and regulation	540	77	0,92
	Pollination	126	18	0,21

STREET 3

Reference: Sven Hultins gata, Gothenburg

Street with less urban charachter. Ditches on the side of the road that handle water regulation and purification and provide pollinator friendly surfaces. The street includes avenues of trees and parking pockets.

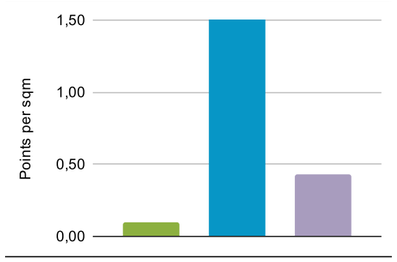


Total area:	**900**	**sqm**
Total points surfaces:	428	17 %
Total points qualities:	2138	83 %
TOTAL (eco efficent area)	**2566**	

GYF-quota:		**2,85**

Symbol		Surfaces	Amount	Unit
	S0	**Hard surfaces**	540	sqm
1	**S1/2**	**Preserved important habitat**		sqm
2	**S1/2**	**Preserved nature**		sqm
	S1/2	**Forrest**		sqm
	S1/2	**Bushes**		sqm
	S1/2	**Rain beds/Ditch**	270	sqm
	S1/2	**Plantings/Cultivation**		sqm
	S1/2	**Lawn**		sqm
	S1/2	**Meadow**	90	sqm
	S1/2	**Big tree**		pieces
	S1/2	**Smaller tree/Big plant**	4	pieces
	S2/3	**Smaller tree in skeletal soil**		pieces
	S2/3	**Plantings/Cultivation/Bushes/Meadow on construction**		sqm
	S2/3	**Sedum on construction**		sqm
	S2/3	**Lawns on construction**		sqm
	S2/3	**Climbing vegetation**		sqm
	S4	**Water**		sqm
	S4	**Wetlands**		sqm

	Green and blue surfaces	**Area (m2)**		**Points**
	Green and blue surfaces	428	0	428
	Quality	**Area (m2)**	**Factor**	**Points**
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	428	0,2	86
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	360	0,5	180
Q20	Vegetated temporary floodplain	270	0,5	135
Q21	Areas specifically designed for the treatment and retention of stormwater	2700	0,5	1350
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	90	1,3	117
Q30	Pollinator-friendly surface	338	0,8	270
	Total:	**4186**		**2138**

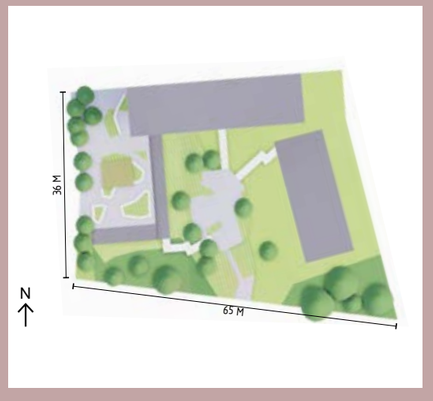


	Balance	Points	%	per sqm
	Biodiversity	86	4	0,10
	Water purification and regulation	1665	78	1,85
	Pollination	387	18	0,43

YARD 1

Reference: Brf Viva, Gothenburg

Semi-open courtyard and forecourts (Partly on floor). The Brf Viva project aimed to strengthen and add ecosystem services to the site. Among other, the project focused on water regulation, pollination, biodiversity, erosion prevention and several recreational ecosystem services. The project also aimed to minimize the impact on the natural slope.

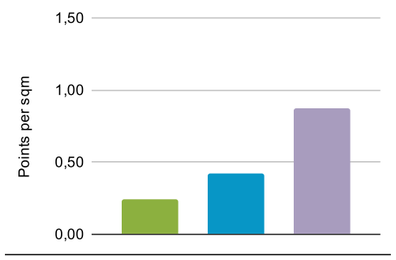


Total area:	**1830**	**sqm**
Total points surfaces:	1805	39 %
Total points qualities:	2795	61 %
TOTAL (eco efficent area)	**4600**	
GYF-quota:		**2,51**

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	504	sqm
1	S1/2	Preserved important habitat		sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest	328	sqm
	S1/2	Bushes	648	sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation	275	sqm
	S1/2	Lawn		sqm
	S1/2	Meadow		sqm
	S1/2	Big tree	3	pieces
	S1/2	Smaller tree/Big plant	15	pieces
	S2/3	Smaller tree in skeletal soil	7	pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction	45	sqm
	S2/3	Sedum on construction	30	sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation	30	sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Green and blue surfaces	Area (m2)		Points
Green and blue surfaces	1805	0	1805

	Quality	Area (m2)	Factor	Points
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	403	0,4	161
Q9	Newly created other nature outside of landscape context	1387	0,2	277
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	1251	0,5	626
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	39	0,5	20
Q22	Stormwater managing trees in impermable surfaces	119	1	119
Q29	Pollinator node	320	1,3	416
Q30	Pollinator-friendly surface	1470	0,8	1176
	Total:	**4989**		**2795**

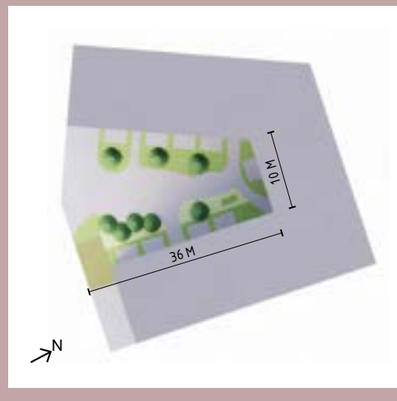


Balance	Points	%	per sqm
Biodiversity	439	16	0,24
Water purification and regulation	764	27	0,42
Pollination	1592	57	0,87

YARD 2

Reference: Kv Botanikern Uppsala, Uppsala

Semi closed courtyard on floor. Project worked with a biotope area factor tool.

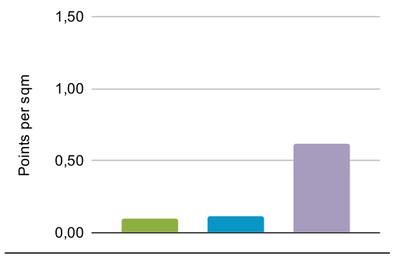


Total area:	**770**	**sqm**
Total points surfaces:	467	42 %
Total points qualities:	636	58 %
TOTAL (eco efficent area)	**1103**	
GYF-quota:		**1,43**

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	439	sqm
1	S1/2	Preserved important habitat		sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest		sqm
	S1/2	Bushes		sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation		sqm
	S1/2	Lawn		sqm
	S1/2	Meadow		sqm
	S1/2	Big tree		pieces
	S1/2	Smaller tree/Big plant	8	pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction	200	sqm
	S2/3	Sedum on construction	45	sqm
	S2/3	Lawns on construction	86	sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Green and blue surfaces	Area (m2)		Points
Green and blue surfaces	467	0	467

	Quality	Area (m2)	Factor	Points
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	381	0,2	76
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	0	0,5	0
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	172	0,5	86
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	200	1,3	260
Q30	Pollinator-friendly surface	267	0,8	214
	Total:	**1020**		**636**

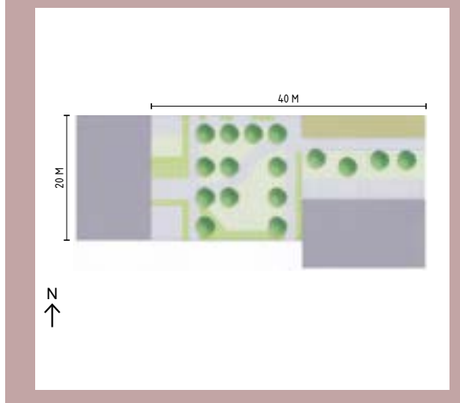


Balance	Points	%	per sqm
Biodiversity	76	12	0,10
Water purification and regulation	86	14	0,11
Pollination	474	74	0,62

YARD 3

Reference: Bo01 Salongen 5, Malmö

Enclosed courtyard with private patios. The Bo01 project was the first project in Sweden to use the green area factor as a tool to plan for ecosystem services. The project aimed to become an ecologically sustainable neighborhood with lots of greenery and water. Great emphasis was placed on planning the inner courtyards to accommodate as much green space as possible.

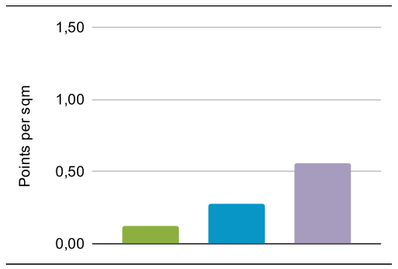


Total area:	**660**	**sqm**
Total points surfaces:	670	52 %
Total points qualities:	630	48 %
TOTAL (eco efficent area)	**1300**	
GYF-quota:		**1,97**

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	262	sqm
1	S1/2	Preserved important habitat		sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest		sqm
	S1/2	Bushes	20	sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation	63	sqm
	S1/2	Lawn	252	sqm
	S1/2	Meadow		sqm
	S1/2	Big tree		pieces
	S1/2	Smaller tree/Big plant	16	pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction		sqm
	S2/3	Sedum on construction	63	sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Green and blue surfaces	Area (m2)		Points
Green and blue surfaces	670	0	670

	Quality	Area (m2)	Factor	Points
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	418	0,2	84
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	335	0,5	168
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	25	0,5	13
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	63	1,3	82
Q30	Pollinator-friendly surface	355	0,8	284
	Total:	**1196**		**630**

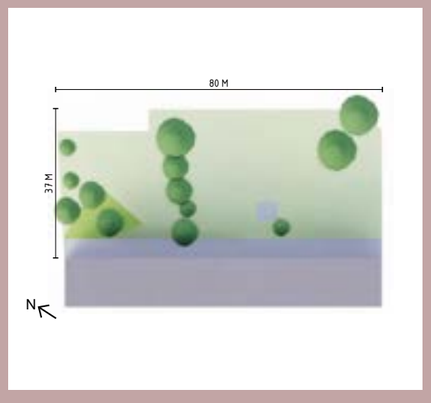


Balance	Points	%	per sqm
Biodiversity	84	13	0,13
Water purification and regulation	180	29	0,27
Pollination	366	58	0,55

YARD 4

Reference: Richertsgatan, Gothenburg

Functionalist residential area with big park-like yards, according to the functionalist motto, light, air and greenery.

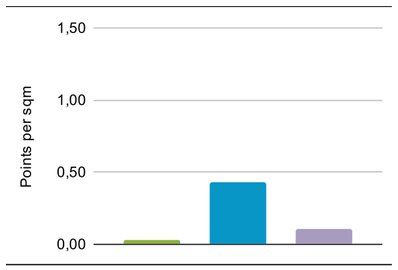


Total area:	**2800**	**sqm**
Total points surfaces:	2622	62 %
Total points qualities:	1584	38 %
TOTAL (eco efficent area)	**4206**	
GYF-quota:		**1,50**

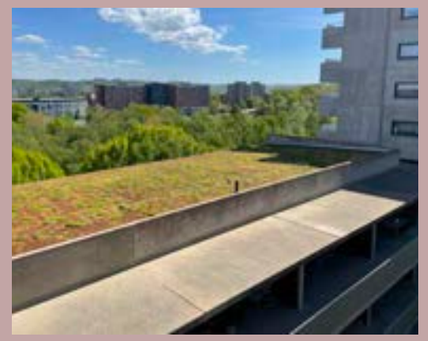
Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	406	sqm
1	S1/2	Preserved important habitat		sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest		sqm
	S1/2	Bushes	144	sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation		sqm
	S1/2	Lawn	2250	sqm
	S1/2	Meadow		sqm
	S1/2	Big tree	3	pieces
	S1/2	Smaller tree/Big plant	9	pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction		sqm
	S2/3	Sedum on construction		sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Green and blue surfaces	Area (m2)		Points
Green and blue surfaces	2622	0	2622

	Quality	Area (m2)	Factor	Points
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	75	0,4	30
Q9	Newly created other nature outside of landscape context	297	0,2	59
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	2394	0,5	1197
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	0	0,5	0
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	0	1,3	0
Q30	Pollinator-friendly surface	372	0,8	298
	Total:	**3138**		**1584**



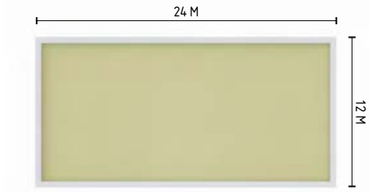
Balance	Points	%	per sqm
Biodiversity	89	6	0,03
Water purification and regulation	1197	76	0,43
Pollination	298	19	0,11



ROOF 1

Reference: Brf Viva, Gothenburg

Sedum covered roof. Can’t be accesed.

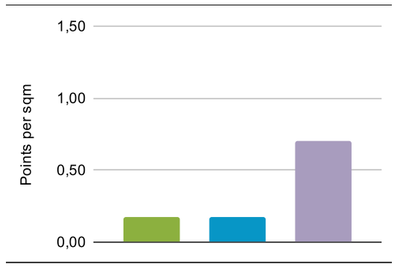


Total area:	**288**	**sqm**
Total points surfaces:	253	45 %
Total points qualities:	304	55 %
TOTAL (eco efficent area)	**557**	
GYF-quota:		**1,93**

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	35	sqm
1	S1/2	Preserved important habitat		sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest		sqm
	S1/2	Bushes		sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation		sqm
	S1/2	Lawn		sqm
	S1/2	Meadow		sqm
	S1/2	Big tree		pieces
	S1/2	Smaller tree/Big plant		pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction		sqm
	S2/3	Sedum on construction	253	sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Green and blue surfaces	Area (m2)		Points
Green and blue surfaces	253	0	253

	Quality	Area (m2)	Factor	Points
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	253	0,2	51
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	0	0,5	0
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	101	0,5	51
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	0	1,3	0
Q30	Pollinator-friendly surface	253	0,8	202
	Total:	**607**		**304**

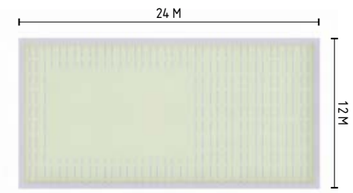


	Balance	Points	%	per sqm
	Biodiversity	51	17	0,18
	Water purification and regulation	51	17	0,18
	Pollination	202	67	0,70

ROOF 2

Reference: Bergakungen, Göteborg

Grass covered roof, meadow character that benefit pollinators. Space for activities.

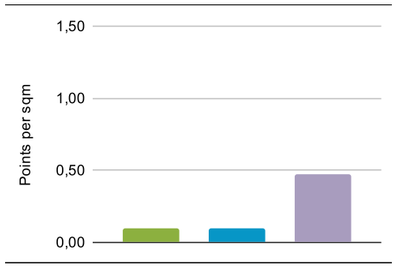


Total area:	**256**	**sqm**
Total points surfaces:	128	43 %
Total points qualities:	172	57 %
TOTAL (eco efficent area)	**300**	
GYF-quota:		**1,17**

Symbol		Surfaces	Amount	Unit
	S0	Hard surfaces	145	sqm
1	S1/2	Preserved important habitat		sqm
2	S1/2	Preserved nature		sqm
	S1/2	Forrest		sqm
	S1/2	Bushes		sqm
	S1/2	Rain beds/Ditch		sqm
	S1/2	Plantings/Cultivation		sqm
	S1/2	Lawn		sqm
	S1/2	Meadow		sqm
	S1/2	Big tree		pieces
	S1/2	Smaller tree/Big plant	1	pieces
	S2/3	Smaller tree in skeletal soil		pieces
	S2/3	Plantings/Cultivation/Bushes/Meadow on construction	36	sqm
	S2/3	Sedum on construction	75	sqm
	S2/3	Lawns on construction		sqm
	S2/3	Climbing vegetation		sqm
	S4	Water		sqm
	S4	Wetlands		sqm

Green and blue surfaces	Area (m2)		Points
Green and blue surfaces	128	0	128

	Quality	Area (m2)	Factor	Points
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	128	0,2	26
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	0	0,5	0
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	52	0,5	26
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	36	1,3	47
Q30	Pollinator-friendly surface	92	0,8	74
	Total:	**308**		**172**

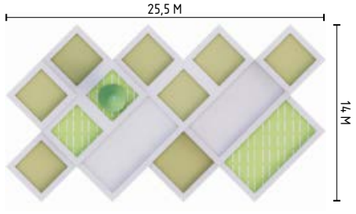


	Balance	Points	%	per sqm
	Biodiversity	26	15	0,10
	Water purification and regulation	26	15	0,10
	Pollination	120	70	0,47

ROOF 3

Reference: 79&Park, Stockholm

Roof with sedum, plantations, private and shared terraces.

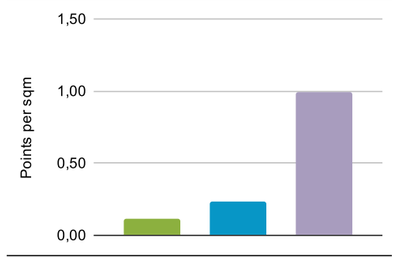


Total area:	**288**	**sqm**
Total points surfaces:	252	39 %
Total points qualities:	388	61 %
TOTAL (eco efficent area)	**640**	

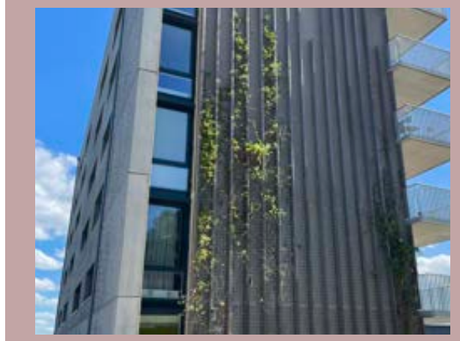
		GYF-quota:		**2,22**
Symbol		**Surfaces**	**Amount**	**Unit**
	S0	**Hard surfaces**	36	sqm
1	**S1/2**	**Preserved important habitat**		sqm
2	**S1/2**	**Preserved nature**		sqm
	S1/2	**Forrest**		sqm
	S1/2	**Bushes**		sqm
	S1/2	**Rain beds/Ditch**		sqm
	S1/2	**Plantings/Cultivation**		sqm
	S1/2	**Lawn**		sqm
	S1/2	**Meadow**		sqm
	S1/2	**Big tree**		pieces
	S1/2	**Smaller tree/Big plant**		pieces
	S2/3	**Smaller tree in skeletal soil**		pieces
	S2/3	**Plantings/Cultivation/Bushes/Meadow on construction**	170	sqm
	S2/3	**Sedum on construction**		sqm
	S2/3	**Lawns on construction**	82	sqm
	S2/3	**Climbing vegetation**		sqm
	S4	**Water**		sqm
	S4	**Wetlands**		sqm

Green and blue surfaces	**Area (m2)**		**Points**
Green and blue surfaces	252	0	252

Quality		**Area (m2)**	**Factor**	**Points**
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	170	0,2	34
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	0	0,5	0
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	135	0,5	67
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	170	1,3	221
Q30	Pollinator-friendly surface	82	0,8	66
	Total:	**557**		**388**



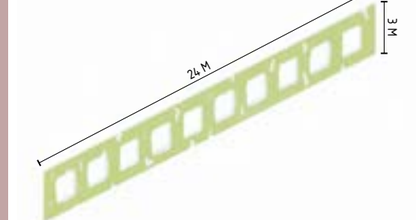
Balance	Points	%	per sqm
Biodiversity	34	9	0,12
Water purification and regulation	67	17	0,23
Pollination	287	74	1,00



VERTICAL VEGETATION 1

Reference: Brf Viva, Gothenburg

Wall covered with wild wine.

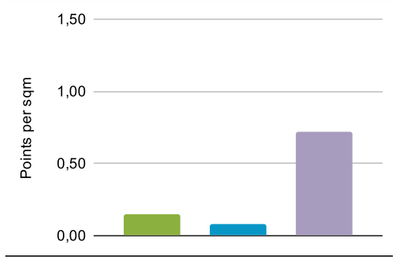


Total area:	**72**	**sqm**
Total points surfaces:	53	44 %
Total points qualities:	68	56 %
TOTAL (eco efficent area)	**121**	

		GYF-quota:		**1,68**
Symbol		**Surfaces**	**Amount**	**Unit**
	S0	**Hard surfaces**	53	sqm
1	**S1/2**	**Preserved important habitat**		sqm
2	**S1/2**	**Preserved nature**		sqm
	S1/2	**Forrest**		sqm
	S1/2	**Bushes**		sqm
	S1/2	**Rain beds/Ditch**		sqm
	S1/2	**Plantings/Cultivation**		sqm
	S1/2	**Lawn**		sqm
	S1/2	**Meadow**		sqm
	S1/2	**Big tree**		pieces
	S1/2	**Smaller tree/Big plant**	2	pieces
	S2/3	**Smaller tree in skeletal soil**		pieces
	S2/3	**Plantings/Cultivation/Bushes/Meadow on construction**	19	sqm
	S2/3	**Sedum on construction**		sqm
	S2/3	**Lawns on construction**		sqm
	S2/3	**Climbing vegetation**		sqm
	S4	**Water**		sqm
	S4	**Wetlands**		sqm

Green and blue surfaces	**Area (m2)**		**Points**
Green and blue surfaces	53	0	53

Quality		**Area (m2)**	**Factor**	**Points**
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	53	0,2	11
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	0	0,5	0
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	11	0,5	6
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	19	1,3	25
Q30	Pollinator-friendly surface	34	0,8	27
	Total:	**117**		**68**

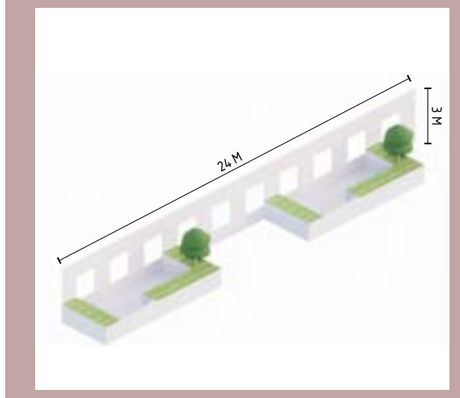


Balance	Points	%	per sqm
Biodiversity	11	16	0,15
Water purification and regulation	6	8	0,08
Pollination	52	76	0,72

VERTICAL VEGETATION 2

Reference: Bosco Verticale, Milan

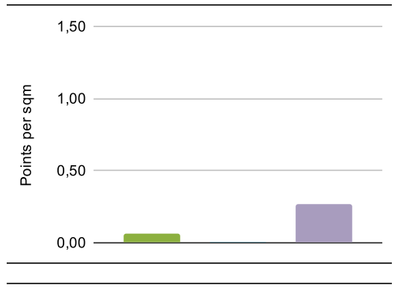
Vertical vegetation in the form balconies with plantings.



Total area:	**72**	**sqm**
Total points surfaces:	48	67 %
Total points qualities:	24	33 %
TOTAL (eco efficent area)	**72**	

		GYF-quota:		**1,00**
Symbol		**Surfaces**	**Amount**	**Unit**
	S0	**Hard surfaces**	72	sqm
1	**S1/2**	**Preserved important habitat**		sqm
2	**S1/2**	**Preserved nature**		sqm
	S1/2	**Forrest**		sqm
	S1/2	**Bushes**		sqm
	S1/2	**Rain beds/Ditch**		sqm
	S1/2	**Plantings/Cultivation**		sqm
	S1/2	**Lawn**		sqm
	S1/2	**Meadow**		sqm
	S1/2	**Big tree**		pieces
	S1/2	**Smaller tree/Big plant**		pieces
	S2/3	**Smaller tree in skeletal soil**		pieces
	S2/3	**Plantings/Cultivation/Bushes/Meadow on construction**		sqm
	S2/3	**Sedum on construction**		sqm
	S2/3	**Lawns on construction**		sqm
	S2/3	**Climbing vegetation**	48	sqm
	S4	**Water**		sqm
	S4	**Wetlands**		sqm

	Green and blue surfaces	**Area (m2)**		**Points**
	Green and blue surfaces	48	0	48
	Quality	**Area (m2)**	**Factor**	**Points**
Q2	Preserved important habitat outside of landscape context	0	0,8	0
Q4	Preserved other nature outside of landscape context	0	0,6	0
Q7	Newly created important habitat outside of landscape context	0	0,4	0
Q9	Newly created other nature outside of landscape context	24	0,2	5
Q18	Watercourses used for the treatment and retention of stormwater	0	0,7	0
Q19	Permeable vegetation-covered natural surface	0	0,5	0
Q20	Vegetated temporary floodplain	0	0,5	0
Q21	Areas specifically designed for the treatment and retention of stormwater	0	0,5	0
Q22	Stormwater managing trees in impermable surfaces	0	1	0
Q29	Pollinator node	0	1,3	0
Q30	Pollinator-friendly surface	24	0,8	19
	Total:	**48**		**24**



	Balance	Points	%	per sqm
	Biodiversity	5	20	0,07
	Water purification and regulation	0	0	0,00
	Pollination	19	80	0,27

CHALMERS
UNIVERSITY OF TECHNOLOGY

2024
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Examiner: Liane Thuvander
Supervisor: Peter Elfstrand