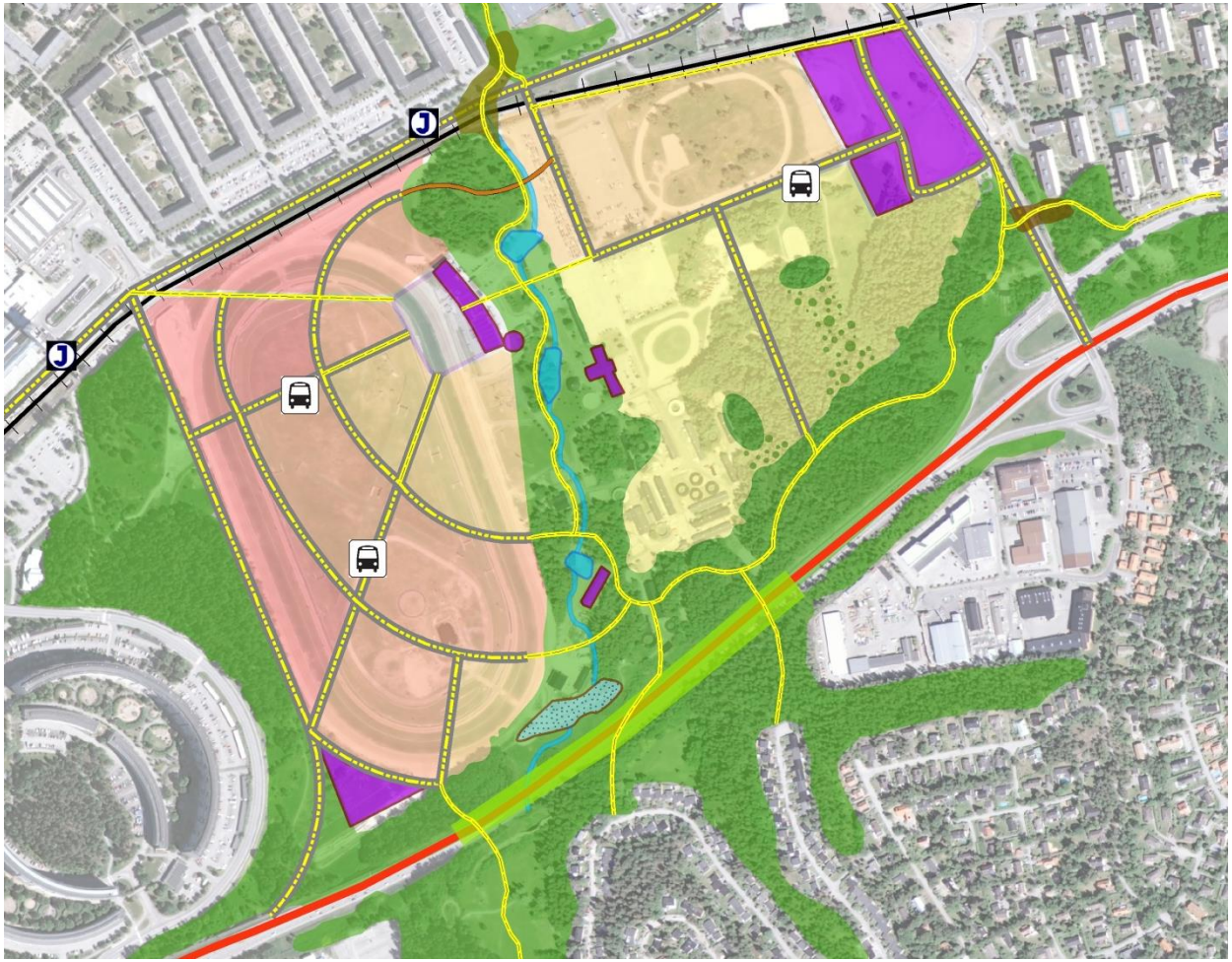
Planning a Sustainable City in Täby Galopp



Course report Environmental Management in Planning

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SUMMARY

Due to the growth of the city of Stockholm, the area of Täby Galopp will be reconstructed to fit 6000 residences and 5000 workplaces. In the environmental plan for Täby municipality certain environmental goals are stipulated and new plans should strive to meet these objectives: Reduced climate impacts; a good water environment; 50% of the area green; a good built environment. The challenge is thus to plan a dense urban environment, but also a green sustainable living environment. Our vision is to create an inspiring city structure with meeting places, a healthy green environment, recreational areas and a mixture of functions that are accessible for everyone.

The major transport routes are designed to encourage more sustainable ways of transport (i.e. public transport, walking, cycling) and to have an area that is easily accessible for inhabitants and commuters. Paper-, plastic- and residual waste will be managed by a vacuum system and a recycling station will be placed for other materials.

Central to the area and on the southern edge, a city park will provide opportunities for recreation and will contribute to physical and mental health. The city park and the implementation of buffer zones will reduce the pollution (noise, air and runoff water) from the E18 and the Roslagsbanan.

Green roofs, small open channels, ponds and a wetland will take care of water pollution and excess storm water. Biologically valuable areas within and outside Täby Galopp are preserved by green connections. The most eye-catching connection is a 564m-long ecoduct-tunnel, which also enhances connectivity for cyclists and pedestrians; the ecoduct-tunnel will also reduce pollution from the E18.

Throughout the whole area there is a mixture of housing, workplaces, shops, restaurants, bars, preschools and elderly care. Additionally, the area is planned with a so-called green gradient in mind. Moving away from Täby centrum in the northwest of the area, the building height and building density will gradually decrease and the amount of green (i.e. trees, urban farming, flowerbeds, and greenery on houses) will increase. The busier area on the west side of the central park is built in a radial structure around a central public square.

The public buildings in this area will contribute to the place identity of the lively city supporting a social healthy environment. Some features around the main square are a greenhouse in the existing grandstand, a vertical farm, a cultural centre and restaurants, and a market with fresh organic produce from the vertical and urban farms. More buildings are preserved to maintain the Täby Galopp identity; one stable will be turned into a science centre and one into a café. In the northeast there is space for a school and some sports facilities.

This plan is a refreshing way of planning in this area. Its peculiar structure and its features will make it an attractive area to live in for a diversity of people. It will also provide work places and attract visitors. Furthermore, the suggested plan takes all the objectives of Täby municipality into account. Climate impacts will be reduced; measures to deal with pollution are implemented; the area will be very green; it will support a lively city and a healthy and sustainable city environment.

CONTENTS

INTRODUCTION

Täby municipality is a part of the growing Stockholm region. The population of Täby is predicted to increase by approximately 10,000 in the next 10 years (Täby Kommun, 2014) therefore there is a need for further development in the area. The municipality's goal is to have a dense city structure in order to connect Täby centrum with Arninge centrum creating a connected city. In the environmental plan for Täby municipality certain environmental goals are stipulated and all new development should strive to meet these objectives (Täby Kommun, 2011):

- **Reduced climate impacts**; reducing greenhouse gas emissions through more efficient resource management and transition towards more renewable energy use.
- **Good water environment**; diminishing stress on surface and groundwater in order to fulfil the EU´s Water Framework Directive requirements.
- **50% of the area green**; nature should be managed in a way that it benefits biodiversity as well as cultural and recreational values.
- **A good built environment;** healthy living conditions where the planning of the built-up area focuses on sustainable management of natural resources.

Part of the development of Täby municipality is the Täby Galopp where the aim is to fit 6000 residences and 5000 workplaces. The municipality aspires to create a living and green town with mixed activities that will attract people of all ages (Täby Kommun, 2013a).

Project Purpose

With these objectives in mind our goal is to portray a vision of how the area can be developed in a sustainable manner. Sustainability is based on three different parts: Economical, Ecological and Social Sustainability. These terms are defined as follows:

- **Ecological Sustainability** constitutes healthy eco-systems resilient to disturbances as well as the use of natural resources that fulfils the needs of the present, in a way that does not jeopardize the requirements of future generations.
- **Social Sustainability** is a combination of aspects ensuring a good quality of life; equality, security, health and well-being, and a good social life.
- **Economical Sustainability** is an economic system that aims to achieve social and ecological sustainability by focusing on long-term profitable investments.

On the contrary, allowing for a dense city structure juxtaposes the ideal of having a sufficient green structure that is sustainable. Our vision is to create an inspiring city structure with meeting places, recreational areas and a mixture of functions that are accessible for everyone. A foundation for that is to incorporate green structures and ecosystem services throughout the area. An additional focus has been on energy efficient solutions.

Environmental Objectives

The parliament adopted 16 national environmental objectives in order to reach "The Generations Goal" (Naturvårdsverket, 2013). Of these 16 objectives, 10 are relevant to this project and have been counted for in the project:

- Reduced Climate Impact
- Clean Air
- Natural Acidification Only
- A Non-Toxic Environment
- A Safe Radiation Environment
- Zero Eutrophication
- Flourishing Lakes and Streams
- Good-Quality Groundwater
- A Good Built Environment
- A Rich Diversity of Plant and Animal Life

Täby Galopp Today

The project areas total size is approximately 600 meters wide and 1,200 metres long, located to the southeast of Täby centrum, other surrounding areas consist of residential houses of different sizes. The Roslagsbanan railway line runs alongside the northern part of the area with two stops, one in "Täby Centrum" and one in "Galoppfältet". Four roads encircle the area with the E18 highway on the south side.

Today the land is managed by Täby Galopp, with the main buildings and different land-uses connected to the horse-racing facility. The ownership of the land is divided between Täby Muncipality (18 %), JM AB and Skanska Nya Hem AB (75 %) and Viggbyholms Estate (7 %) (Täby Kommun, 2013a). Even though the municipality only owns a minor part of the area, they are the governmental agency responsible for approving the local development plan. Therefore they are the agency responsible for setting the environmental standards for the development companies and accepting the Environmental Impact Assessment (EIA).

Besides the horseracing facility there are remnants of previous land use visible in the landscape, such as historical graves and pastures. These sites possess important ecological and cultural values.

GENERAL AREA STRUCTURE

The overall vision on how to achieve all the proposed goals and handle the associated trade-offs and problems is visualized in the general physical plan of Täby Galopp (Figure 1).

A large city park of 236.660m² stretching from the centre to the southern edge of the site will provide inhabitants, employees and visitors with opportunities for recreation thus contributing to mental and physical well-being. Further, the vegetation will reduce noise and air pollution, while the ponds and wetland connected by a stream remediate water pollution and excess storm water. All the existing biologically valuable areas are preserved. Two of these areas are situated outside the actual park and thus within the built-up city matrix. However they are connected to the park with extra green spots between the buildings. Biodiversity is enhanced by green connections to larger natural areas surrounding Täby Galopp. To the north, there is a fauna passage across the green tracks of the railway, consisting of abundant vegetation. A small bridge for bicycles and podetrians is covered with vegetation and creates a connection to the east. In the south, a 564m-long ecoduct-tunnel enables green connectivity, transport connectivity for bicycles and pedestrians, as well as protection from noise, air and runoff water pollution emmissioned by vehicles passing the E18.

Public buildings will contribute to the place identity of the lively city centre of Täby, supporting a social and healthy environment. Inside the city park, gastronomy and a science centre are located in preserved buildings, which presently function as stables. On the edge of the city park, in the heart of Täby Galopp, a cultural centre will be established in the existing grand stand in connection to the vertical farm tower thus establishing a significant landmark. The preservation of the three buildings in Täby Galopp is beneficial for place identity and accentuates the historical function of the site. The vertical farm stands as a symbol for Täby Galopp as a green, sustainable and future oriented city. Outside the park, various public squares, sport facility fields, and urban gardens contribute to the overall green feeling of Täby Galopp. Other elements, such as schools, car parks, and a waste management site are carefully integrated in the overall concept. (Figure 10 and Figure 30).

The major transport routes in the area are designed to minimise car use, while maximising public transport, walking and bicycling. An important feature is that the so-called car roads also provide for safe, separated pedestrian walks and bicycle lanes and the so-called bicycle lanes are combined with pedestrian walks. The pedestrian paths however are only accessible for walkers in order to conserve the high biological value of the specific area. The connection between the eastern and western part of Täby Galopp is only possible via numerous pedestrian and bicycle tracks crossing the park. Several connections between Täby Galopp and other parts of Täby municipality are provided for easy passage to and from Täby Galopp.

The area of 437,387 m² between the major transport routes consists of a diverse variety of residence buildings, workplaces, shops, restaurants, bars, kindergartens, and elderly care. A smaller grid of streets in between the buildings provides connection to the major transport routes; however, they are not showen on the map. The four different colours of the developed areas indicate four different average heights of buildings. This will create a gradient from lower buildings in

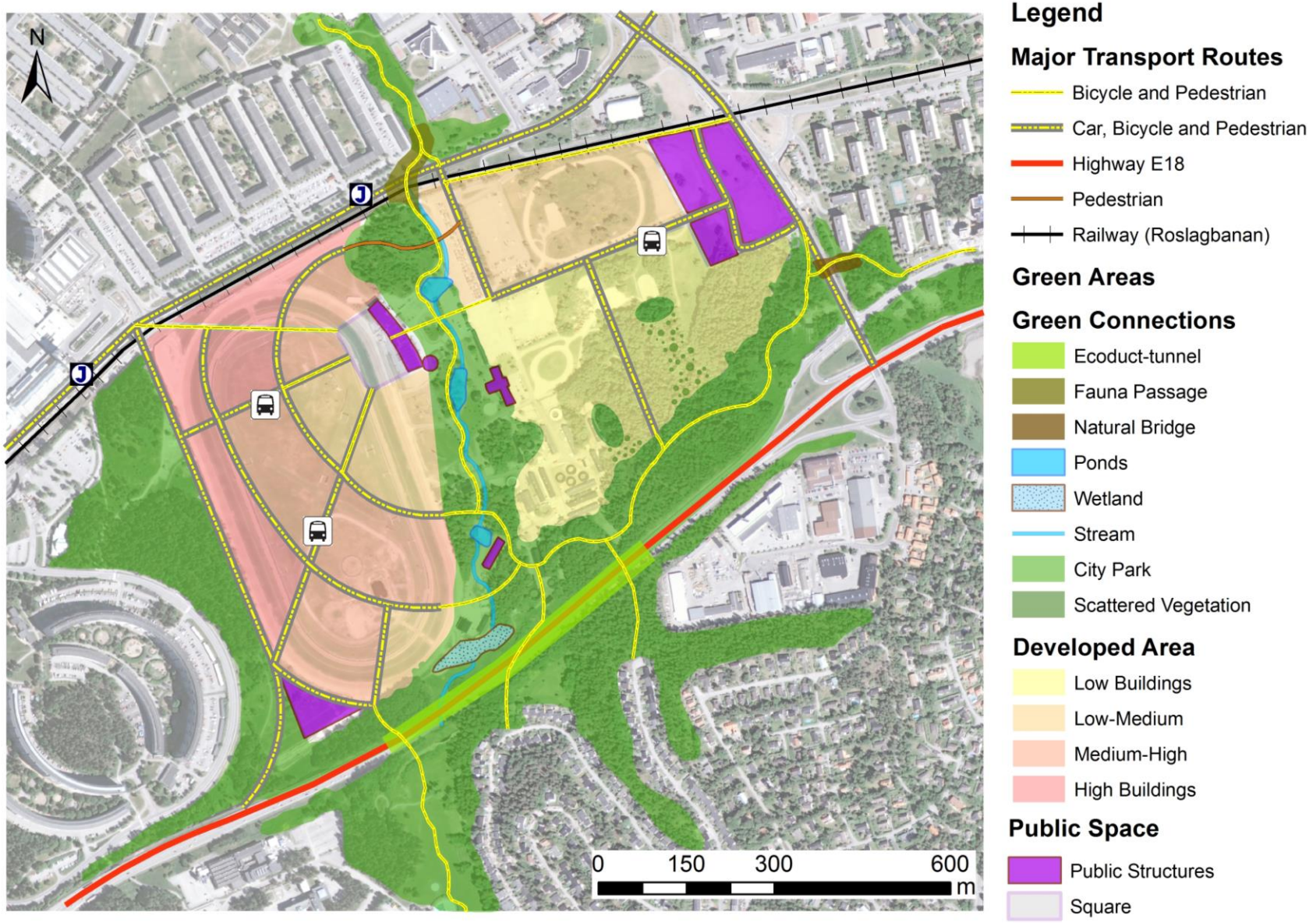


Figure 1 General plan for Täby Galopp, as proposed by the authors of this report.

the greener south-eastern corner to higher buildings in the more city-like north-western corner of the site. This architectural gradient consists of lower buildings with up to 3 floors, medium-low and medium-high buildings as well as high buildings with up to seven floors. In order to guarantee private underground parking lots for all residents of a building, the building can have a maximum of 5 floors (source: meeting with Täby municipality). By including higher buildings in the plan, not every inhabitant will have a carpark. This will discourage car use, especially in the high rise buildings, while there will be some extra space in the lower buildings of 3 to 4 floors.

In order to solve the problem of high groundwater levels, Täby municipality has proposed to place the basement level of all new buildings on the current ground level. The areas in between the buildings will be filled up with soil. This construction method will allow for an open channel flow of storm water to the water areas in the park, where the lower, present altitude is conserved. Additionally, the former valley structure of the landscape will be regained. Gardens, green streets and green roofs will enhance green connectivity, biodiversity and public mental and social well-being throughout Täby Galopp.

Green gradient

Gradient 1. Green spaces. Going from "wild", natural rather untouched area in the south with a forest to "civil" or "City" with orderly parks and well-defined spaces.

Gradient 2. Architecture. The arrangement, looks and function of the houses also takes up the idea of (Swedish) identity, with smaller houses mirroring the traditional Swedish "gård" to high rise buildings at the northern upper end of the gallop field. Here the race track structure could be maintained supporting the local identity.

Gradient 3. Density. The closer to the centre, the denser the buildings are to be arranged, creating a sense of landscape variation (Figure 2).

Why urban green spaces matter

The association of access to urban green space and mental and physical health has been discussed and established in several recent studies (Douglas, 2012; Nutsford et al., 2013; Richardsons et al., 2013) and is an essential part of city planning (Grahn and Stigsdotter, 2010). This up to date research inspires us to plan the Täby Galopp area in a fashion that offers the residents a *diversity* of urban green space, varying in aesthetics and function. We call these varying urban green spaces the *Green Gradient Concept*, the purpose of which is to inspire people in all social/age groups to experience and interact with nature by offering a wide range of green settings, for both active and passive involvement.

One study shows that human health and well-being benefits from urban green space, vegetated areas and water bodies and that closeness to urban green areas make people more likely to be physically active, which has a positive effect also on the mental health (Douglas, 2012). Another study discusses how urban green spaces can be viewed as elements of importance to public mental health (Grahn and Stigsdotter, 2010). The study explains how individuals with various mental stress statuses prefer different types of "sensory dimensions", or types of green space, concluding that some types of green settings can have a more stress relieving impact than others depending on what state one is currently in (Grahn and Stigsdotter, 2010). We believe that these findings support the idea of offering the

residents of Täby Galopp a range of different types of green settings, in accordance with the green gradient concept.

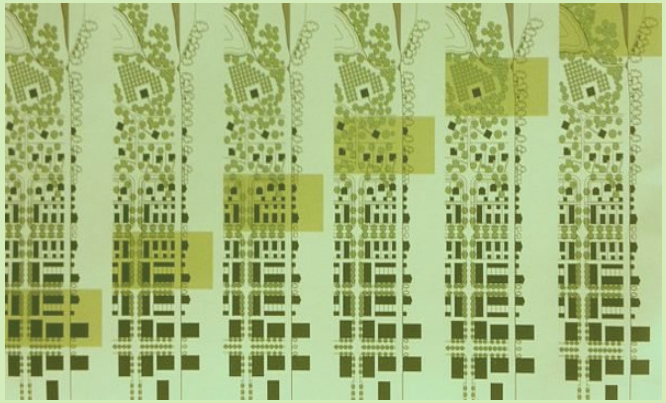


Figure 2 Illustration of the **Green Gradient Concept**: the urban green space will change in character as we move closer to the more and more built environment, which will be most concentrated in the north west of the area, closest to Täby centrum. From a more forest like environment in the southeast of the Galopp to a more city like, planned and structured green setting in the

Forest like tracks

In order to put forward the green gradient idea we started off looking at the current topography within the area. In the southeast corner there are existing horse riding tracks in a relatively hilly terrain, consisting of a mix of coniferous and foliferous trees, dead trees and moss covered rocks. The idea here is to keep as much as possible of this "untouched" environment, preserving the horse tracks but converting them into illuminated tracks for jogging or walking. These tracks run along the highway and preserving the trees and the hilly terrain would also work as a sound and pollution barrier from the noise caused by the heavy traffic along the E18. The idea is to make people associate this area with *untouched nature* and *forest.* The main function of the area would be recreational in that way it would mainly offer a place for the residents to be physically active, by walking or jogging on the tracks in a forest like setting.

Physical activity facilities

In the far east of the Galopp area we plan for schools and belonging green spaces, adapted to the need of children and teenagers, in the aspect of creativity, learning and physical activity. In this area we want the children to interact and experience nature and will therefore offer sporting facilities for instance a football field, ice rink and a skate park but also mix this with green spaces to have a more relaxing interaction such as gardening in allotments.

Rural and rustic possible farmer's market

The next step of the gradient involves the planned city park, which will run from the E 18 in the south to the rail road tracks in the north. If we start off looking at the south end of the park, there is currently a vegetated area along with several stables. The idea here is to preserve the vegetation in the far south as it is, more or less, and also to preserve one or two of the already existing stable structures, to renovate into farmer's market, flee market or conversely converting them to a playing facility for children. There are many options for what you could use the stable structures for. One reason for preserving and restoring them is to enhance the cultural history of the area and create a

sense of local identification, which up until today has been a horse track. In terms of the green gradient concept, the idea is to make the south end of the less anthropomorphized to instill the concept of the rural idyll.

Park life

As we move further north, away from the stables and more towards the heart of the park, the green space will gradually change in character and give the perception of being slightly more planned and designed. The shapes of gravelled walking paths will be organically rounded, which goes for the design of the overall planted vegetation as well. It will be possible to sit down on the grass or on a bench, in the shade below a droopy willow tree, enjoying the scenery of the park. We would like to construct three little ponds in the centre of the park, where reed and water lilies would enhance the experience of being a tranquil environment.

Urban Gardening and Greenhouses

As we move further north, above the heart of the park, the green spaces will become more defined. Rows of planted vegetation, allotments for public gardening and more social life and activity with cafés and shops will be prevalent as we gradually reach the city centre square. Attached to the centre square is the old grandstand of the horse racing, which will be preserved but converted into a structure that serves as both a cultural centre but also housing a greenhouse that residents can access. The already existing plateaus of the amphitheatre-like structure will be converted and used for plantations and urban farming. The structure will also be able to house shops and cafés or cultural events. Furthermore, attached to the old horse racing structure is the vertical farm, the land mark and tourist attraction of Täby Galopp, which will not only offer locally and organically produced food but will also be part of the green design and green experience of the Täby Galopp area.

The Green In Between

The overall vision of planning for a green and varied Täby Galopp incorporates the idea of designing the entire city scape as green as we possibly can, horizontally and vertically. Therefore we want to plan for green rooftops and facades in all build structures and residences, both for the purpose of the green visual experience that this would offer the residents and visitors but also for the purpose of using these green spaces as an ecosystem service. The green rooftops/facades will vary in function between being provisional in character, in other words used as urban farming spaces, as an aesthetic experience, but will also function as remediating elements for noise, water, air and soil pollution, in this way increasing biodiversity by using different types of plants species.

The arrangement, looks and function of the houses and built structures will take up the idea of (Swedish) identity, with smaller houses mirroring the traditional Swedish “gård” (farm) in the south-eastern end to high-rise buildings at the northern upper end of the gallop field. The closer one gets to the centre, the denser the buildings will be arranged, creating a sense of landscape variation.

PROPOSAL FOR STRUCTURE ELEMENTS

Networks

Transportation networks

The overall transportation network is visualized in figure 3. There are four major routes in the planning proposal. One of the major roads in the proposed plan is a pedestrian road on the north west of the map which provides connectivity from the Täby Centrum area to the central square. The other major routes are car roads, which enable people to travel around the area. However, the two car roads leading to the Cultural Centre and the Central Park are equipped with automatic retractable bollard system to prevent motor vehicles access. Even though cars will not be allowed to go through the central park, the bike lane and jogging path between the central square and the major car road in the eastern part will be wide enough for ambulances and firetrucks to go through in case of emergency.

The main road pattern on the western side is of a radial pattern, with the centre located at the central sqaure. The minor roads between these planned major routes will be planned to integrate an organic grid structure in order to achieve a good connectivity with small blocks of buildings.

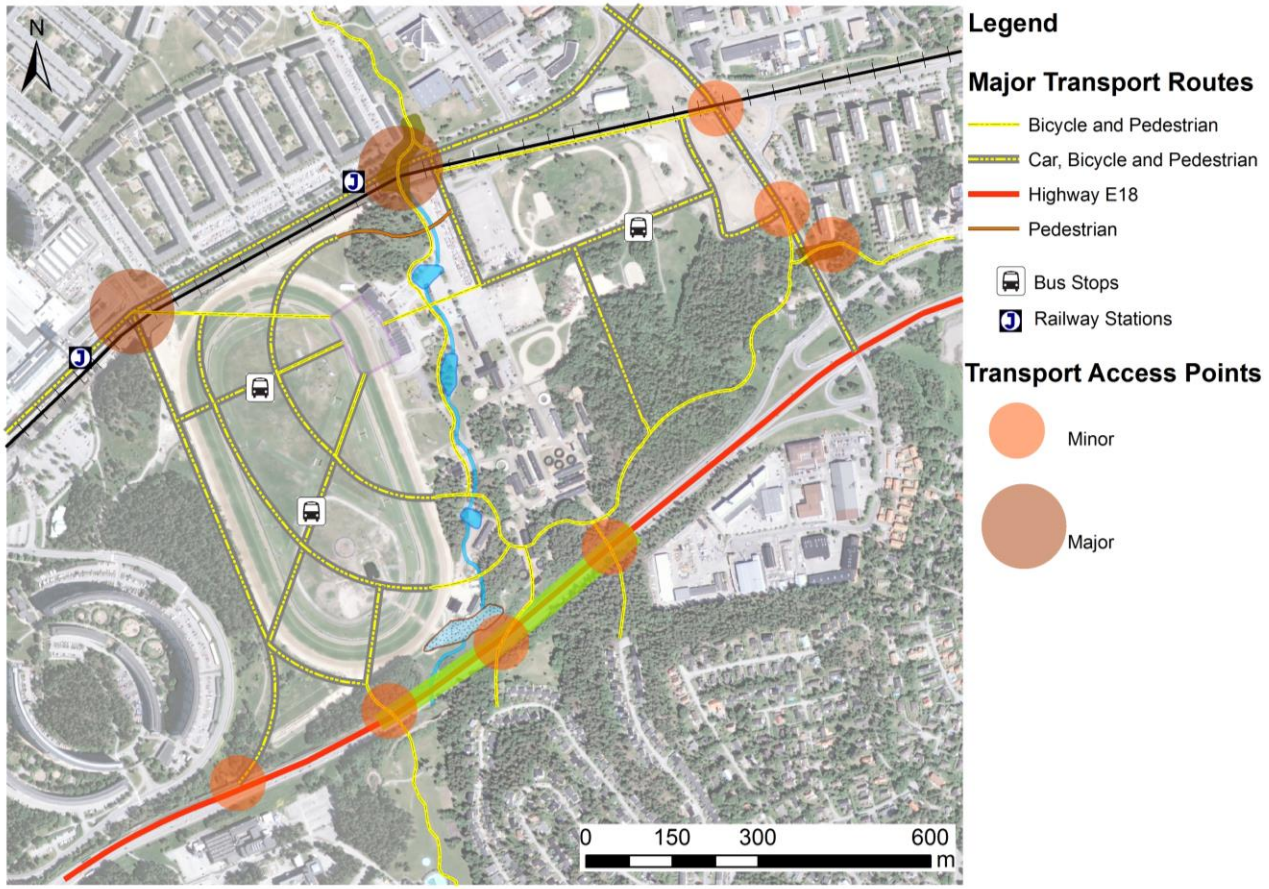


Figure 3 Map showing transportation routes, access points and public transport.

As for parking space, the garages will be built on the basement level of the buildings. Because of the high ground water level in Täby Galopp the basements will be built more or less on top of the present ground and the areas in between the buildings will be filled up with soil up to the ground level. In addition, there is a parking lot located in the southwest corner of Täby Galopp (Figure 30).

In addition, to persuade people not to use cars, there will be a speed limit of 30 kilometres per hour on all car roads in the community.

All roads are constructed with environmentally friendly materials such as recycled asphalt. They also need to be equipped with properly lighting to ensure security to road-users especially at night. In addition, there will be vegetation planted along the side of major roads to reduce airborne particles. A simple row of trees lining a street can potentially reduce airborne particles by 25% (Warren, 1973), whereas traffic generated airborne led on a leeside of a hedge may be reduced by 40% (Raad, 1965 cited in Madders and Lawrence, 1985). Vegetation alongside of the roads also contributed to providing protection from cold winds during winter, providing shade in summer, aesthetic enjoyment, noise protection, etc. (Givoni, 1991) .

In order to improve accessibility, we propose a co-operation with SL to extend bus services into Täby Galopp community by adding three bus stops, two at the car roads leading to the cultural centre and one at the east side of the community (Figure 3).

Benefits

Due to the nature of the area which is quite windy, a grid road pattern will create wind tunnels. A radial pattern, however, will prevent this from happening. In addition, radial patterns offer a more efficient means of movement within the city, which is one of key aspects in creating a sustainable city from a security perspective (Boverket and Infab, 2011).

Having a speed limit inside the community will ensure road safety especially for pedestrians and bikers. In addition, by limiting some roads to be only pedestrian and bicycle paths, it will ensure that more people will use them (Boverket and Infab, 2011).

Moreover, the automatic retractable bollard system will be set to allow delivery of shop supplies in the early morning, and will be raised during other hours. It will restrict automobiles and trucks to enter an area, while allowing pedestrians and bicycles to go through. This retractable bollard system looks quite attractive compared to other barrier options such as traffic gates or barricades. In case of emergency, it can be easily signalled to retract and allow access.

Environmental friendly material such as recycled asphalts reduces quarrying, mining and oil consumption. It is one of America's most recycled materials where 70 million tons of Asphalt pavement materials are reclaimed every year. More than 99% of the reclaimed materials is reused or recycled. It is also porous, which allows it to be used as a tool in storm water management (EAPA and NAPA, 2011). As for the toxicity concerns, Anja Enell et al. (2013) state that the toxic effects from leaching and vapours from reclaimed asphalt is not significant.

Drawback

Having car traffic inside the community, results in many types of pollution such as air and noise pollution. However, this is necessary, because the community is dependent on cars. Moreover Roslagsbanan, which is a major public transportation route, is also a source of pollution. This can be improved by a proposal to SL for the greening of tram tracks (which is discussed in the Air and Noise Pollution section).

Minimizing car use, maximizing biking and walking

People in Sweden think that it is important to reduce car usage because of its environmental effects, but few actually take actions (Hagman, 2003). Some actions that encourage people to minimize car use and maximize walking, bicycling and using public transportation are listed below.

Actions that encourage people to use other alternatives than private cars (Mackett, 2001):

- The government could encourage such action by means of publicity campaigns.
- Have a good and safe network of walk paths and bicycle lanes that have good connectivity to the area around.
- Good parking facilities for the bikes.
- Have a parking lot on the edge of the area and good connection to all parts of the area with walk paths and bicycle lanes.
- Have a station where you can rent a bike. Both near the parking and the cultural centre so that people can leave the bike at several places.
- Keep the paths clear of snow during the winter time
- Good public transportation system, with high frequency
- Good connection to public transportation and good accessibility to railway stations, make it easy to exit and enter the stations.
- Hold the costs of public transportation down, as cheap as possible.
- Safe environment on the streets such as have good street lighting for both traffic and people safety.
- Shower facilities at workplaces.
- The presence of local shops, short distances from houses to grocery stores.

To implement these ideas into the Täby Galopp, there will be:

- A well-planned bicycle lane system in which the lanes are separated from the streets with some kind of a barrier like tree growth. The lanes will be one-way cycle tracks and where they are alongside a street they will follow the direction of the traffic (Figure 4).
- A walking and bicycling path going through the city park with connection to all green areas around, with the use of green ecoducts.
- Well lit up walking paths and bicycle lanes so that people feel safe when travelling by night.
- A big parking lot on the edge of the area to encourage people to leave the car and use other ways of travelling within the area. There will be a station where people can rent bicycles and these stations will be present on several places in the area, for example one by the Roslagsbanan and one in the central square.
- Very good bicycle parking facilities all over the area. This will make people feel safe to leave their bicycles,

especially by the train station and by the central square, as well as, for all the residential houses and businesses.

- A maximum speed limit of 30 km/h in all the streets so that people that are walking and bicycling feel safe.
- As there will be some areas that are car-free, it is important that the walking paths are wide enough for ambulances and fire-trucks in case of emergencies.

One example of a country that promotes bicycling as a mean of transport is the Netherlands.
Bicycling in the Netherlands has become a very popular way of transportation and they have a substantial position to non-motorized modes of transport. In 2004, more than 16% of the total road network was devoted to bicycle paths (Rietveld and Daniel, 2004). An official national bicycle policy was implemented to include the importance of well-planned bicycle lanes and parking facilities as well as good connections between paths. The planning of the bike lanes is focused on the safety of the cyclists and through thoughtful road architecture as well as the education of bicyclists and car drivers about the rules of the road. Rule number one is to respect other drivers, including bicyclists (Osberg and Stiles, 1998).

There are several benefits of using other modes of travel than private cars. It is not only good for the environment but also for the public health (Pucher and Dijkstra, 2003). By making bicycle lanes and walking tracks safe and attractive to people, more people are likely to choose that way of transportation. In addition, the public transportation system has to be well implemented with fare number of stops and high frequency of departures for people to completely stop using private cars.

The problem that might occur with this limitation of car use is that it is not possible to force people to change their habits and it has to be done gradually. In an article by Hagman(2003), some Swedish car owners were interviewed, one woman says that she would probably manage without a car but she also said: “You get very dependent once you have it” (Hagman, 2003). This shows that it requires a lot of cooperation from the residents of the area. One way to gain some cooperation is to arrange a seminar for the people living in Täby Galopp with a main focus on advantages of using other ways of travelling than the private car. As an incentive, free metro card of 100 SEK are given as a gift to those who participated.

When encouraging people to use public transportation for longer distance travels it is very important that the accessibility to the railways is good and that there is a good connection to the train stations and a safe place to park bicycles and leave them over a short period of time, for example over a weekend or just over the day. In Netherlands they try to implement this into the planning of railway stations and in 2000, 23% of the travellers used bicycles to travel to and from railway stations (Rietveld, 2000).

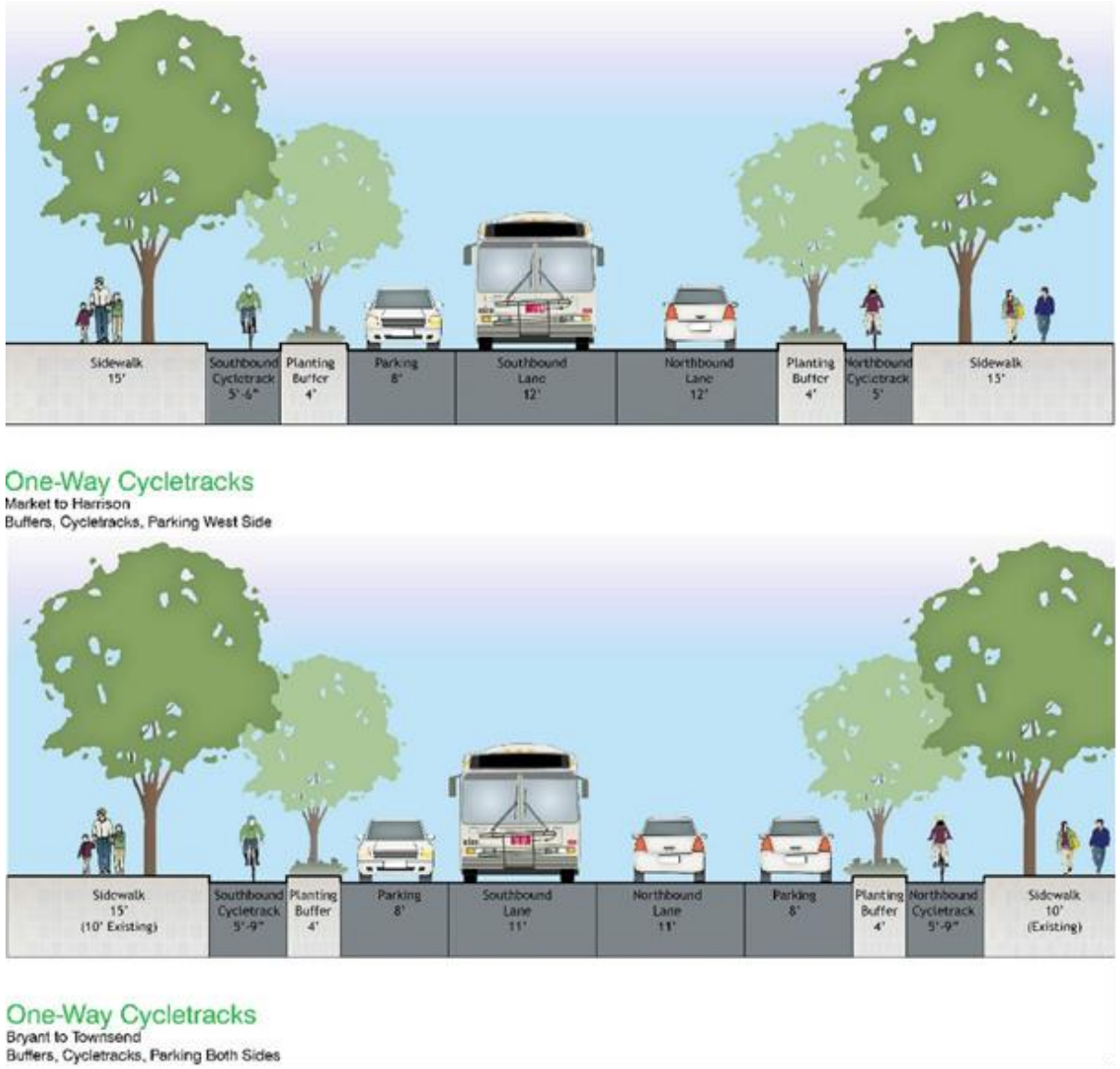


Figure 4 An example of how the streets will look like, with the combination of car roads, bicycle lanes and walk paths.

Green connectivity

Habitat loss, which involves the deterioration of habitat quality, is the greatest threat to biodiversity today (Hanski, 2011; Seiler and Folkeson, 2006; Zaviezo et al., 2006). Furthermore, fragmentation and isolation will have evolutionary and genetic consequences in the future, such as reduced variability and extinction debts. Today there is a constant conversion of natural habitats to residential and industrial areas, agricultural land, plantations and infrastructure etc. propelled with increasing population size and more densely populated areas, which will accelerate the demand for recourses (Hanski, 2011). Sustainable societies with good supporting services (good quality green areas, connectivity, biodiversity) are of major importance to sustain ecosystem services (Tscharntke et al., 2005), such as regulating services (pollination, purification etc.), cultural services (cultural recreation areas) and provision services (food production) in urban areas (Green et al., 2014). Creating or maintaining connectivity are increasingly common conservation measures and important objectives in physical planning, to enhance biodiversity and variability within populations (Lacher and Wilkerson, 2013).

What is eco system services?
"The ecosystems' direct and indirect contributions to human well-being" (Naturvårdsverket, 2012a.).

There are many different kinds of passages to enhance connectivity between and within fauna populations. Depending on the landscape, target species and habitat affected, the most appropriate type is selected. Different types of passages are landscape bridges or ecoducts, wildlife overpasses, viaducts and river crossings, underpasses for large and medium sized animals, underpasses for small animals etc. The frequency of fauna passages depends on the target species and the distribution of the habitat types in the area. In general, more fauna passages are needed in natural areas e.g. wetlands, forests etc. than in urban areas. However connectivity in urban areas with many barriers can be essential to maintaining the continuation of the green countryside. Solutions to these cases can be to integrate all remaining green corridors. Landscape bridges, such as ecoducts are the most optimal choice for most animals to disperse (Iuell et al., 2003).

Because of the high ground water level in the Täby Galopp area, we have chosen ecoducts in most cases (Figure 5). Important connections between the area of Täby Galopp and its surroundings are described below.

- Implementation of a green corridor (1) in the centre of the Täby Galopp. Connection to an area with high nature an recreational value (2) south of the race course and to Stolpaskogen (3) north of the planning area.
- Implementation of an ecoduct or planting of grass (4) over the railway to connect to green area (5) and Stolpaskogen further north.
- From Stolpaskogen improvement on green area (6) is necessary to connect to the nature reserve (7) west of lake Rönningesjön. Also green corridors (8) are needed south of the lake.
- From the nature reserve, a green corridor (9) is needed to connect to existing areas with high recreational value (10) south of the nature reserve. Also an ecoduct (11) has to be built to cross the E18.
- South of Täby Galopp an ecoduct tunnel (12) is suggested, to increase the green area (13) in the study

area and to favour dispersion of more species. (For more information on the ecoduct tunnel see: Noise Reduction)

- Green corridors (14) are needed near the harbour, south of study area to connect to bigger green areas west and south of existing green areas (15).
- An ecoduct (16) is needed at Roslags Näsby station to connect to existing green corridors to the north (17).
- Green corridors (18) are needed northwest of Täby Galopp to connect to existing green areas (19).

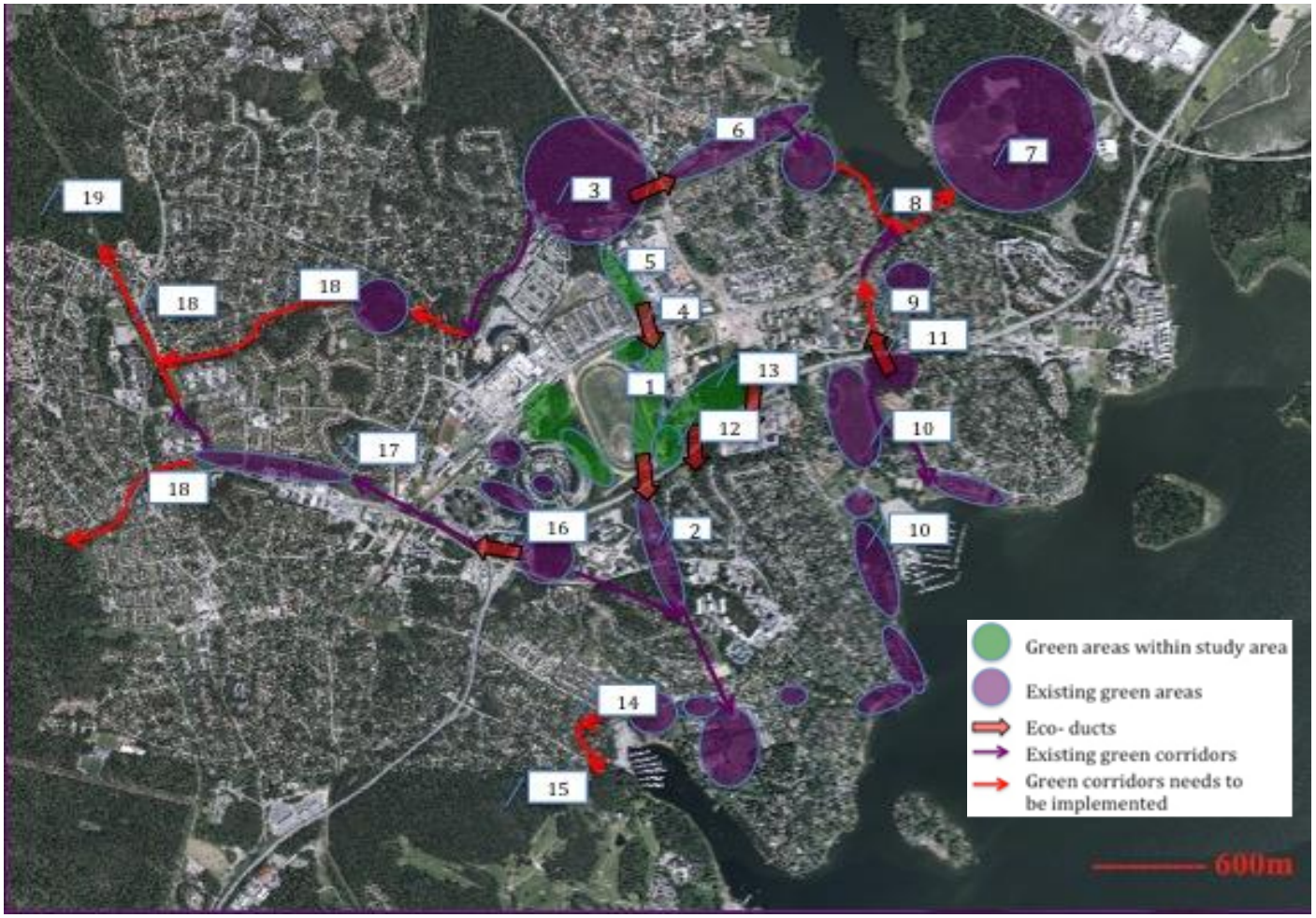


Figure 5 Map showing the ecological connectivity between Täby Galopp and its surroundings and the suggested connectivity solutions.

Ecoducts

Ecoducts (Figure 7) are special constructions designed to facilitate animal crossing over a highway (Iuell et al., 2003). The busy highway E18 that goes along Täby Galopp contributes to fragmentation of species habitats and consequent reduction of populations of local fauna. Therefore, the possibility of ecoducts being positioned in the area to connect to surrounding green areas is vital for Täby's habitat restoration and maintenance of species richness, especially as the area is predicted to increase in human population density. The *Migration Potential Theory* must be taken into account when deciding the dimensions and placement of the ecoducts.

As a result of this, the potential benefits on the local ecology are determined by the design, dimensions and other technical properties of the ecoduct (Seiler and Folkeson, 2006).

Migration Potential is calculated as:

Ecological Migration Potential

multiplied with

Technical migration potential

The Netherlands is on the frontier in the development of ecoducts.
This ecoduct stops the dissection of the largest nature reserve in the Netherlands, *De Veluwe*, into two parts. The length of the ecoduct seen in figure 6 is 150 m, and it has been successfully used by various terrestrial mammals such as the shrew, red deer and the pine martin.

Figure 6 Ecoduct near Kootwijk in the Netherlands.

The following principles for building ecoducts should be taken into account in Täby Galopp: firstly, there is the issue of placement; ecoducts should align themselves with existing natural animal pathways. Secondly, dimensions are very important; the minimum width required for species such as deer to cross is 7 meters, and the average width of ecoducts is 45 m (Iuell et al., 2003). However, an ambitious ecoduct-tunnel of 564m is planned over the E18 south of the city park, not only for animal dispersion, but also to provide more green areas for inhabitants. Furthermore, it will connect transport routes for bicycles and pedestrians and reduce noise, air and run-off water pollution from the E18.

Figure 7 Example of an ecoduct in Can Pagá, Vallés Oriental, Spain.

Storm water management

The aim with this section is to make a water balance model based on the physical plan in order to identify the volume of water flows from different areas and to estimate the need for storm water control areas in Täby Galopp. Some proposals for water cleaning and handling will also be included.

Attenuation of runoff and flows plays an important role in water regulation for the planned city. The retaining capacity of vegetation represents an effective way of evening out runoff when flows are high. For example, green areas can retain water and therefore moderate the flow downstream. Attenuation of runoff relies on and impacts upon the water eco-cycle, nutrient circulation, erosion, sedimentation and local climate. Vegetation plays an important role in filtering and capturing/absorbing airborne pollutants and contaminants that come via water from paved surfaces: roads, roof, etc. Pollution is filtered through the soil and nutrients are absorbed by the vegetation. This will reduce the pollution load on the water recipient. As with climate change, there is an increased need for local delay of storm water to prevent flooding of urban water and wastewater systems (Naturvårdsverket, 2012).

Requirements as stated by the municipality

The preliminary planning vision for Täby Galopp by the municipality states that storm water shall be handled locally within the central park area. The existing ground water level will affect the layout of the storm water system and so potentially several pumping stations will be required. Measures will be needed to handle the water quality requirements for the recipient Stora Värtan. A dam will be constructed in the western part over an area of 6500 m^2. A small wetland is proposed in the east. Storm water from the highway E18 should be kept outside of the storm water system (Täby Kommun, 2013a).

Water balance estimation

As the storm water has to be handled predominantly within the local area, the evapotranspiration must be equal with the precipitation. The 1961 to 1990 climate reference monthly precipitation values for Stockholm (SMHI) indicate the highest rainfall in July with about 2.32mm/day. There are 15 days /year with more than 10mm rainfall and the highest data (from 1857) indicates 121mm.

For the Täby Galopp area, 750,000m^2 in size, this corresponds to 7500m^3/day at 10mm precipitation and 1,125m^3 at the yearly average of 1.5mm that needs to be handled mostly locally. Modelling this on a conceptual model based on the existing proposal (Täby Kommun, 2013a), the water flow can be estimated. Using the ballpark figures, put forward by Bolund and Hunhammar (1999), for evapotranspiration, interception, infiltration, storage together with the available information from Täby municipality, the remaining runoff per day from the different areas can be estimated as follows below (Table 1).

Table 1
Water balance model for Täby Galopp, with calculations based on the preliminary planning vision provided by Täby Municipality.

Zone	Area m²	Runoff factor	Runoff m³/day 1.5mm rain	Runoff m³/day 10mm rain
Green roof harvesting	160000	0.05	240	1600
City park	110000	0.2	165	1100
Old forest	80000	0.1	120	800
Road/bio filters	60000	0.1	90	600
Local Parks	40000	0.2	60	400
Absorbing Surfaces	300000	0.1	450	3000
Total	750000		1125	7500

This implies that the design of other absorbing surfaces will have high impact on the water fed to the open storm water system. If the system is designed to store and handle the 1.5mm rain, an additional temporary storage is needed for the 10mm rain of 6,400 m³/day. That means the ponds and wetland with an area of 12,500m² need to be constructed to have the surface move up and down about half a meter by some form of terracing. The flood control area shown in the conceptual map is about 65,000m². With a depth of 0.1m this can be used as a temporary flooding area handling an additional 10mm of precipitation. As a comparison, the ecocity of Augustenborg in Malmö can handle 70% of the precipitation on a yearly basis (Dajotoy, 2013).

Implementation of fluvial flood control

A small stream will run through the city park from Roslagsbanan in the north down to the highway E18 in the south (Figure 9). There will be several small ponds and a wetland in the south part. A flood control area is situated along the stream to take care of the days with heavy rainfall. Otherwise this area can be used for normal park activities. The stream will be lined with stones for better water oxygenation and evaporation (Figure 8). In the wetland there is an area with suitable vegetation for reducing the nutrient load in the stream water.

Figure 8 Small stream with pond. Example from Märsta water park.

Storm water bio filters - Rain gardens

Storm water bio filters have the ability to remove nutrients and pollution from storm water. Reliable pollutant removal during the cold season is particularly important due to the comparably high contamination levels in winter time. The bio filters are situated along the major roads in the area. They are also essential for watering the trees along the streets.

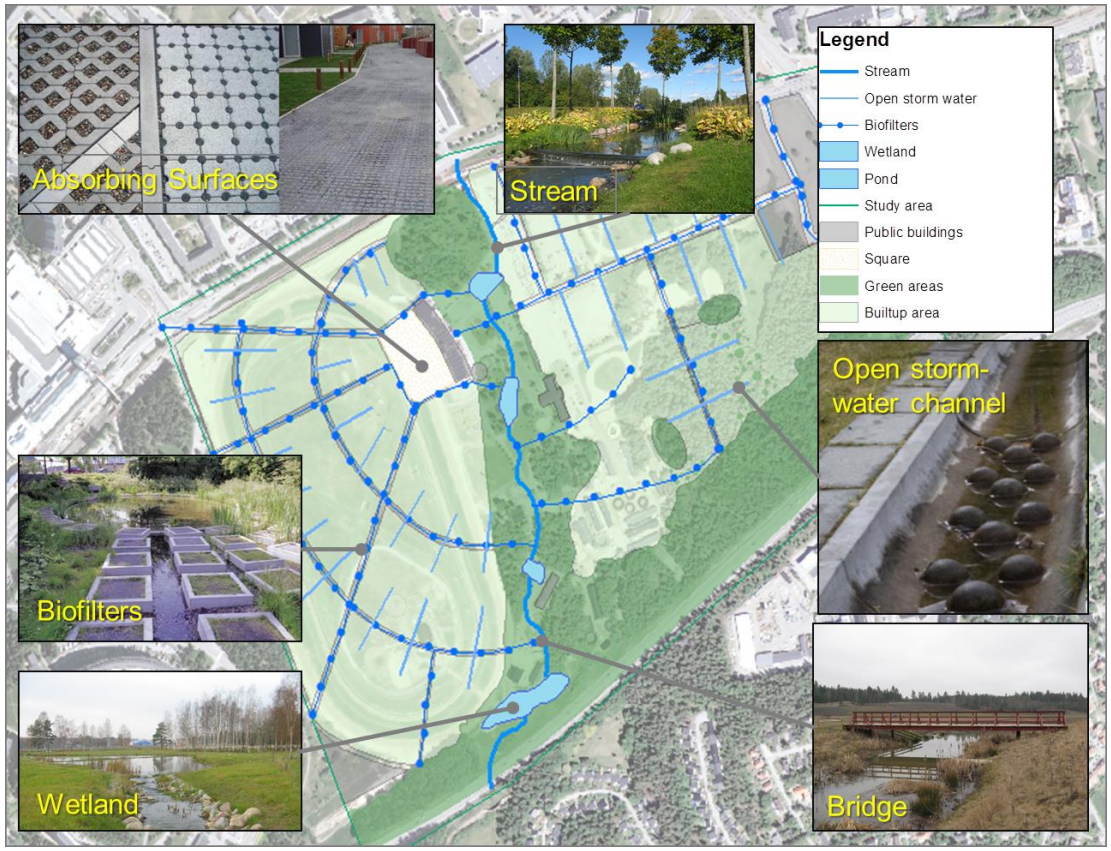


Figure 9 Potential locations for fluvial flood control conceptions in Täby Galopp overlaid on an ortophoto.

Open storm water channels

Excess water from the green roofs and hard made surfaces are fed to small open channels along the buildings and minor roads. The open channels are fitted with onion like obstacles for better water oxygenating and evaporation. The channels are then connected to the stream and ponds through "rain gardens", situated along the major roads, where the water slowly runs through a filter of vegetation and soil. Hazardous substances are then filtered. The implementation is depended on the actual topography of the area. Pumps can be needed (Dajotoy, 2013).

Green roofs and rainwater harvesting

Green roofs and walls are created by seeding and planting various moss and stonecrop plants (*Sedum*). Plant watering by rainfall is sufficient and maintenance is limited, consequently the system is essentially self-sufficient. Rainfall is intercepted by the vegetation and part of it is evapotranspirated back into the air, the rest infiltrates to the drainage layer where it is stored according to

the capacity of the substrate. Excess water is then fed to the storm water system. The effect is less volumes to the storm water system, protection of roof cover materials, better biodiversity, less noise, less heat transfer and is considered aesthetically pleasing to the eye (Dajotoy, 2013). Excess rain water can also be harvested and fed to greywater tanks to be used for gardening in dry seasons (Klein, 2011).

Bridges and viaducts

Small viaducts are used when crossing roads and walk paths. The viaduct area must be designed to handle the maximum storm water flow of 30 years. The viaducts will also have some small areas along the stream enabling small animal species to safely move through the area and connecting to green areas in the north and south..

Absorbing hard surfaces

Hard surfaces need to be able to drain water when possible (Figure 9) leading the rain water down to a system of pipes that connects to the open storm water system as the soil is mostly clay in the area. This will also have a positive impact on street trees and biodiversity. Absorbing hard surfaces should be applicable for small roads/walkways and park areas (Schouenborg, 2012).

Maintenance costs and impact on economy

Wetlands, streams and open storm water systems need to have maintenance plans for continuous high performance. Debris has to be removed and vegetation harvested. Green roofs and walls are to be watered, fertilized and the grass cut.

The major impact on economy will be in the areas of water quality improvements and declining storm water volumes. That means less effort is needed to get the recipient Stora Värtan to meet the quality requirements stated by "Havs- och Vattenmyndigheten". As storm water from the area is limited the risk of storm water flooding into the waste water system is reduced and the cost for the Käppala waste water treatment plant will be much lower (Täby Kommun, 2013a).

Impact on society

The implemented water landscape crossing the area will facilitate orientation for people moving in the area. The streams and ponds provide experiences for people and at the same time provide technical functions and safe corridors for small species (Täby Kommun, 2013a).

Wastewater management

Täby municipality is a member of the municipal association called Käppalaförbundet. Käppalaförbundet owns and operates Käppala sewage treatment plant on Lidingö (Täby Kommun 2012b). Käppala sewage treatment plant is one of the world's most effective treatment plants and extracts biogas and bio-fertilisers from the sludge (Käppalaförbundet, 2012). Täby Galopp will be connected to the current sewage system.

To increase the local environmental sustainability of waste water in Täby Galopp, greywater can be reused. Treated greywater can be used for flushing toilets, urban gardening and vertical farming and it is possible to use bath water for heating up the buildings (Chao et al. 2012; Eriksson et al., 2002). In

Täby municipality greywater is combined with the sewage water and goes to the sewage treatment plant; but this can be separated with a greywater system which is based on different plumbing for sewage water and lightly used greywater (Nolasco, 2011). The greywater has to be treated to avoid contaminations or pollutions before usage (Eriksson et al., 2009). The location of the sewage treatment will also be at Käppala sewage treatment plant, Lidingö.

In California, in 2010, the Greywater Standard was implemented.
This meant that greywater systems were installed for free; in turn this makes it easier for people to reuse greywater. (Nolasco, 2011)

Benefits and drawbacks

Käppala sewage treatment plant is one of the most efficient treatment plants in the world, which minimizes the emissions from sewage (Käppalaförbundet, 2012). Greywater reuse will decrease the water use and conserve natural resources.. There is a risk that the greywater is contaminated or polluted and therefore it has to be treated before use (Eriksson et al., 2009).

Waste management

The waste management planning in Täby municipality is handled by the Town Building Office (Täby Kommun, 2013b). Täby municipality is one of nine partners in SÖRAB (Södehalls Renhållingsverk AB, 2009), which is responsible for the treatment of domestic waste and operates recycling centres. The participating municipalities in SÖRAB shall work towards a joint waste management plan for 2020. In the plan, eight overall targets are included (Table 2, SÖRAB, 2008). The waste management in Täby Galopp has to adapt to the current system in Täby municipality and work towards achieving the different targets.

Table 2 The overall targets from the waste management plan.

Overall Target	Description
People-centred	Waste management shall be based on peoples need and shall be accessible for both the ones who pick up and leave the waste.
Quality	All waste shall be correctly sorted and shall not litter.
Reduce the amount of waste	Resource management shall be stimulated to reduce the amount of waste.
Reduce the hazardousness of waste	Hazardous waste shall not be mixed together with other waste.
Increase material reuse	Reuse of material and products shall be initiated
Increase recycling	At least 50% of the domestic waste shall be recycled and the recycling from the operation shall increase.
Energy production	Combustible waste which cannot be reused or recycled shall be used as fuel. Biogas can replace fossil fuels.
Deposition	Deposition should only occur if there are no other possible treatment options. Closed landfills shall not be a risk for the people or the environment.

The waste management in Täby Galopp will mainly be a stationary vacuum system: an underground system which transports the waste through pipes. There are two different types of vacuum systems: a stationary vacuum system and a mobile vacuum system. The stationary vacuum system is automatic and the waste is transported from storing containers under the garbage chute within each building to collecting containers at the vacuum system station. The transport distance through a stationary vacuum system can be as long as two kilometres. The mobile vacuum system collects the waste in storage tanks located under the chutes which are connected to a docking point. The distance between the tanks and the docking point can be up to 300 meters. (Avfall Sverige, 2009) Since the stationary vacuum system will cover the whole area with only one station it is chosen for Täby Galopp.

On practical and economic grounds it is recommended to sort the waste into a maximum of three fractions (Miljö- och Projekteringbyrån i Mälardalen AB, 2009). In Täby Galopp the vacuum system will be used for paper, plastics and residual waste. The different fractions are transported through the same pipes but the transportation occurs separately; which ensures that there is no mixture between different types of waste (Envac, 2009). Currently it is Förpacknings- och Tidningsinsamlingen AB handling the collection of plastic, paper, metal, glass and newspapers at the recycling stations in Täby (Täby kommun, 2013b); this means that the company needs to collect the paper from the vacuum system station, and it is advantageous to place the vacuum system station and the new recycling station at the same location (Figure 10).

Glass and metal are not suitable for the vacuum system and have to be submitted to a recycling station (Miljö- och Projekteringbyrån i Mälardalen AB, 2009). To reduce heavy transports through the area, the recycling station will be placed adjacent to the vacuum system station; this means that the citizens have to transport this kind of waste by themselves to the recycling station. Currently existing recycling stations which are close to the area are located at; Bergtorpsvägen, Södervägen/Bergtorpsvägen, Åkerbyvägen and at Nytorpsvägen (Täby Kommun, 2013c).

Example of waste management #1
Stationary vacuum systems are currently in use in Hammarby Sjöstad, where it was implemented in 1997 and supports three different fractions (Envac, 2014a) and in Wembley City where it was implemented in 2006 and supports four different fractions (Envac, 2014b).

Food waste can attract pests, produce moulds and when the digestion starts, the energy content decreases (Smedlund Miljösystem AB, 2007). In Täby municipality it is not permissible to install or use food waste disposers that are connected to the sewage system (Täby Kommun, 2012a); this means that waste disposers are not an option in Täby Galopp. A solution to the problem with food waste is dry preservation, for example Somnus (Käppalaförbundet, 1975). Dry preservation of food waste means that the waste is sorted into a specially adapted paper bag and dried in a drying machine in a customized drying house (Avfall Sverige, 2009). Dried food waste is lighter and has a smaller volume, there is no smell and the digestion stops. Dry preservation produces biogas and bio-fertilisers as well, and a possible distributor might be Käppalaförbundet; which already produces biogas used as

vehicle fuel (Käppalaförbundet, 2012). Emptying is only needed about twice a year due to the long storage times, which in turn results in less transportation. It is calculated that one Somnus-machine connected to 200 households draws 6,570kWh per year and produces biogas equivalent to 45,000kWh per year (Smedlund Miljösystem AB, 2013).

Residual waste will be handled by the vacuum system and then burned for extraction of district heat. A CHP plant is planned at Hagby (Isacsson, 2013), which is a part of SÖRAB and located in Täby municipality.

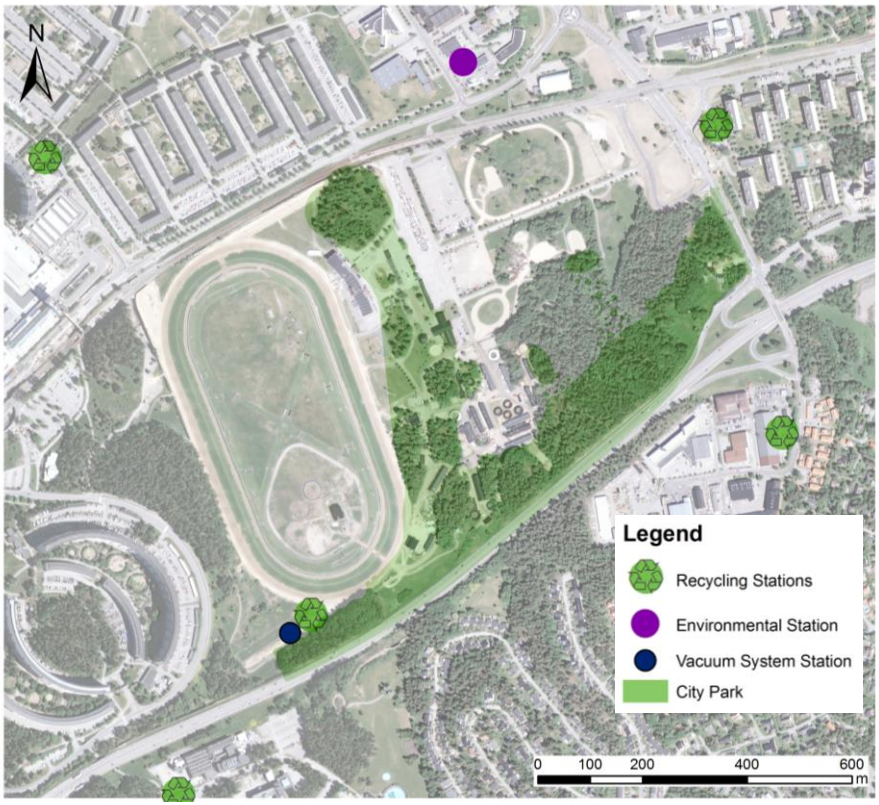


Figure 10 Map showing locations of waste collection facilities.

Example of waste management #2
Self-emptying waste containers are in use at Mariatorget in Stockholm, with a project start in 2010 (Envac , 2014c) and in Odense Havn where it was implemented in 2009 (Envac, 2014d).

The hazardous waste in Täby municipality is handled by SÖRAB. Täby has five different environmental stations where hazardous waste can be submitted, including one located close to Täby Galopp (Figure10) (Täby Kommun, 2013d); this means that no new environmental station is planned for the area. Täby municipality is applying a hazardous waste-car, which means that hazardous waste can be submitted and sorted with the help of knowledgeable staff close to the residences (Täby Kommun 2013e). This should be implemented in Täby Galopp as well to reduce the amount of hazardous waste in the domestic wastes.

Waste management for streets and parks will be handled by self-emptying waste containers. The emptying will happen automatically when the trash can is full and the waste will be transported by the vacuum system to a container in the terminal (Envac, 2013).

Location of waste collection facilities

The vacuum system will be located underground with garbage chutes inside of every building, the self-emptying waste containers will be located within a regular distance at streets and in the park and the collecting containers and recycle station will be located at the south west part of the area (Figure 10). The submission of hazardous waste will be at its current location: Statoil Täby Galopp.

The size of the vacuum system station is about 250 m^2 (Miljö- och Projekteringbyrån i Mälardalen AB, 2009). The vacuum system station can be placed up two kilometres from a chute; the longest distance in the area where the vacuum system will be applied is roughly 1200 m; which means that only one station is needed within the area and it can be placed wherever it does not disturb. The vacuum system station can be noisy and therefore it is located close to the freeway; a place that already is noise polluted and considered less attractive for residences (Miljö- och Projekteringbyrån i Mälardalen AB, 2009).

Benefits and drawbacks

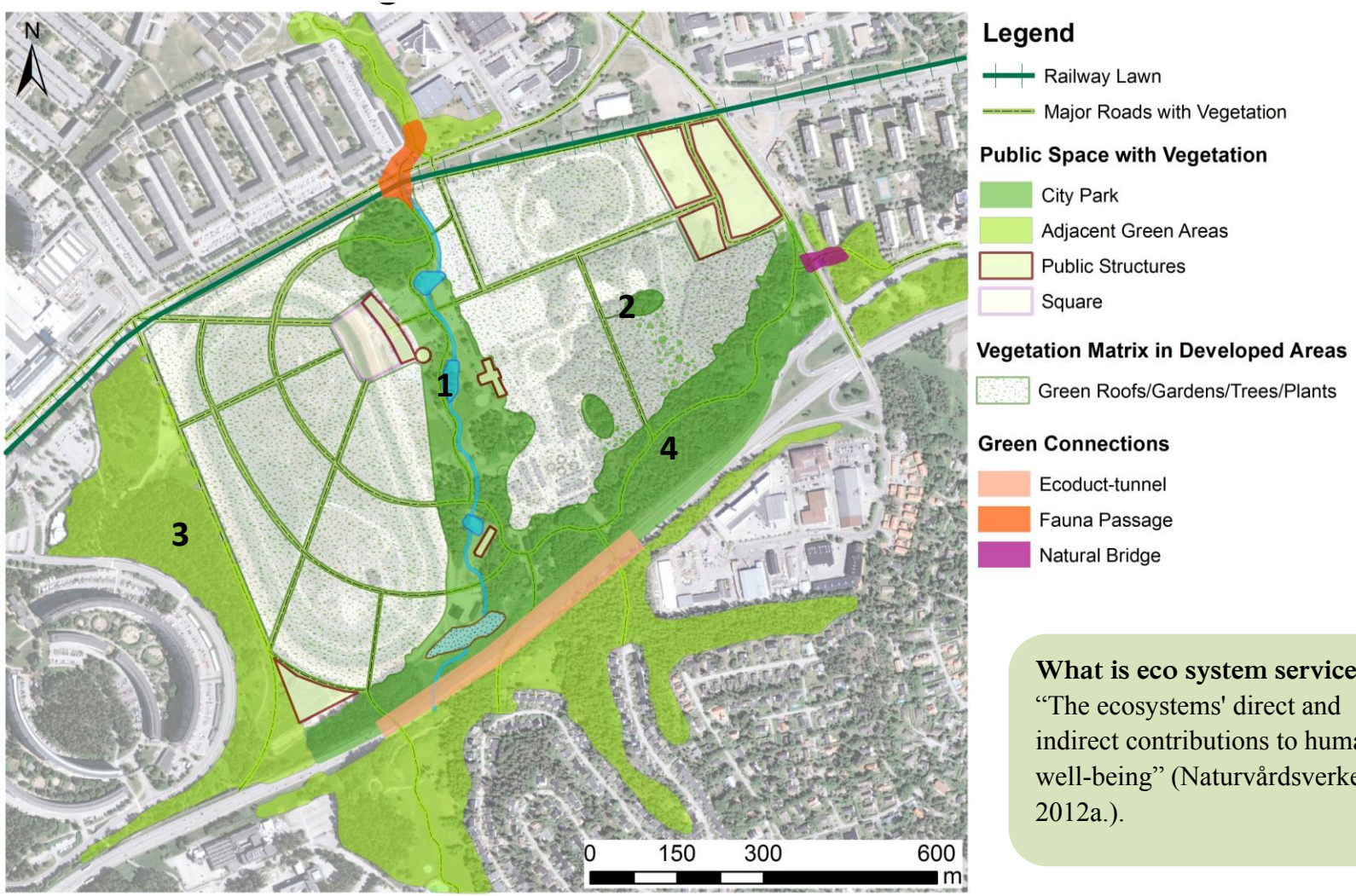
It is fundamental for sustainable waste management that it is easy to use for the residents and it fits their everyday life; which the vacuum system does. The amount of heavy transports through the area will decrease due to the location of the vacuum system station and the emissions from transport will decrease due to fewer and shorter transports. Both the vacuum system and the dry preservation of food waste will decrease the health problems caused by pests and reduce the smell from waste (Miljö- och Projekteringbyrån i Mälardalen AB, 2009; Smedlund Miljösystem AB, 2013.). The dry preserved food waste will be easy to handle, have a smaller volume and contribute biogas for vehicle fuel and bio-fertilisers. The self-emptying waste containers will decrease the amount of litter, pests, smell and transportation (Envac, 2013).

The targets that the proposed waste management solutions affect are: people-centred, quality, reduce the hazardousness of waste, increase recycling, energy production and deposition.

The drawbacks of the vacuum systems are that the investment cost is expensive, noise can occur when the waste is collected, it is hard to inform and communicate with a great amount of households and there is a risk for problems with the technology (Miljö- och Projekteringbyrån i Mälardalen AB, 2009). A disadvantage of dry preservation is that it is a new solution and the system has not been established on the market yet. Another negative aspect is when the recycling of materials such as glass and metal are on a different place it can be hard to get all the people to recycle their waste instead of throwing it in the residual waste.

Example of waste management #3
Dry preservation of food waste is currently being implemented in Göteborg, where a reference plant is located (Avfall Sverige, 2009).

Green areas



What is eco system services?
"The ecosystems' direct and indirect contributions to human well-being" (Naturvårdsverket, 2012a.).

Figure 11 Map of green areas in Täby Galopp. Nr 1 is central park, nr 2 and 3 are small parks and nr 4 is "wild forest".

Biodiversity

To keep and enhance the biodiversity in the area of Täby Galopp several green areas are planned (Figure 11) to be constructed, including a city park placed in the middle. It is also planned to preserve the parts of the area that today already contain high natural values (Calluna, 2013). The creation of small recreational areas and green spots around area´s with high natural values are two ways to improve the connectivity and to maintain the original biodiversity in Täby. In the more urbanised parts of the area, biodiversity is enhanced by planting on balconies and roofs, and in the streets. Smaller "parks" or green spots between houses and buildings are also planned.

The whole area of Täby Galopp should keep a variety of endemic Swedish species and old cultural plants. The smaller park areas in Täby Galopp with high natural value should try to represent the old Swedish grazing areas with semi-open grazed lands and old pine trees evenly spread out. The central park could resemble an older type of Swedish garden

Why is biodiversity important?

When talking about ecosystem services, one of the most important issues is to maintain biodiversity within urban areas. Diversity within an ecosystem or green area enhances the resilience to cope with unpredictable events, disturbances and pollutions. A high plant density gives animals the opportunity to establish in the area. A diversity of species brings a broad spectrum of abilities that is the ground work of the ecosystem services we are interested in using (Keune et al., 2013).

Green areas and biodiversity

The green areas in Täby Galopp should solely contain traditional Swedish plants. The reason to do that is to as close as possible resemble old Swedish agriculture landscapes, a type of landscape that is on its way to disappear. With the disappearance of these landscape types the ecosystems connected to them are on the brink of extinction. Traditional agriculture landscapes contain much higher biodiversity than modern forestry or big scale agriculture. The two industries focus on big areas with one or two crops and give little space for other plants whilst traditional small scale agriculture extorted a varied land use which favoured a great variety of species (Nitare, 2014). One way to preserve the traditional biodiversity and local flora and fauna is to incorporate old grazing lands into parks and recreational areas, and to plant local and traditional flowers and herbs in city flower beds and balconies. By doing this in several cities and villages biodiversity is saved and preserved globally.

Usage of traditional plants also increases the feeling of cultural heritage and can widen the knowledge of agriculture and botanic history of the inhabitants in Täby.

What is biodiversity?
"Variability among living organisms from all sources including, inter alia. Terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (UN, 1992).

The central park

A big park is planned to extend diagonally through the centre of Täby Galopp. The purpose of the park is to serve as a meeting point for residents and workers close by and to add to the green feeling of the area. The park should also serve as a green link between southern and northern Täby. It should therefore be easy to access and an open space for people to relax in. These types of areas are often lacking in biodiversity. To increase the biodiversity in the central park the vision is to resemble an old Swedish garden with fruit trees and edible plants and bushes. The goal is to exclusively plant nontoxic and preferably edible plants. This is an ecosystem service for the children and adults using the park.

Figure 12 Example of possible arrangement of Swedish plants with explanatory signs in the botanical garden in Uppsala. Photo: Annika Aspenberg

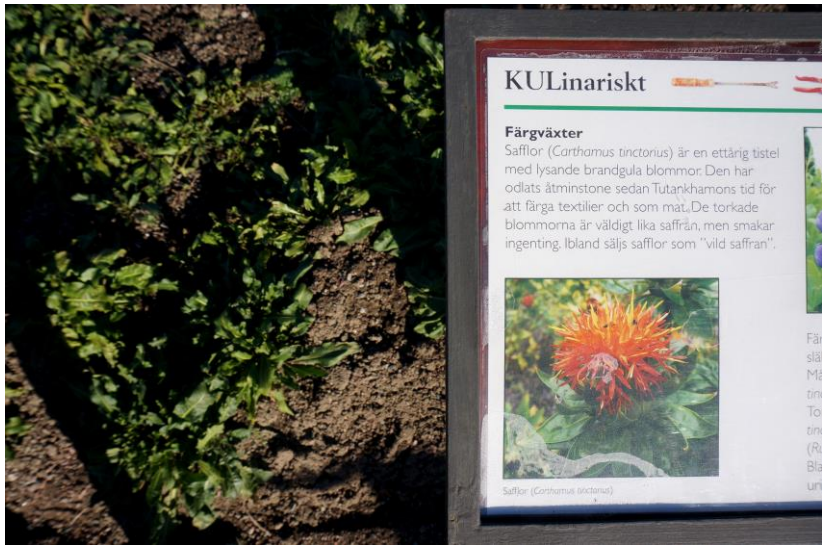


Figure 13 Example of explanatory sign. From the botanical garden in Uppsala. Photo: Annika Aspenberg

Several species of grass and small flowers should grow freely on the ground. The composition should mimic a meadow rather than a lawn. Trees and bushes should stand in irregular pattern to bring shade but also offer open areas with sunlight and space for playing and recreation. Swedish apple, pear or cherry trees but also rowan and elderflower are examples of possible trees and black currant, gooseberries and lilac are perfect bushes (Figure 12)

Flowerbeds in the park should contain traditional Swedish herbs and berries such as strawberries, garden cress, rhubarb, lavender, mint, sage, marigold and others. Signs can be placed with names and descriptions of the different herbs revealing some background information. Examples similar to this nature

can be observed in Uppsala botanical garden and Eskilstuna city park (Figure 13).
Urban gardens are a viable method of diversifying species richness in the park; however it has to be done with caution. Invasive species, if used, could spread from the gardens and compete with the native species.

Small parks

Areas with high natural values will be saved and preserved as small scale parks and green areas (Figure 14). These areas resemble traditional grazing areas with varied ground vegetation that should be managed and cut one to two times each summer. Old pine trees and junipers grow in these areas, both important in a biodiversity perspective. In these areas deadwood should be kept untouched and the plants and grass should grow in a more wild style. This is an important elements for biodiversity as well as to create gradient landscape style for recreation purposes.

> Traditionally, grazing animals kept the area open, naturally rinsing the landscape from dominating plants (Nitare, 2014). Removing bushes and high plants at a regular but not common basis could be done by machine.

The wild forest

The forest that grows along E18 is to be kept as unmanaged as possible to add another habitat to increase the biodiversity within the area, but also to bring other ecosystem services locally.

Urban greenery

Urban greenery is all the greenery within the built area. Examples of this may be alleyways, groups of trees and greenery between the houses and on buildings, and flowerbeds in the centre of the town. These small green spots between buildings is important to keep the connectivity within the area as the parks and green spots in Täby Galopp is not going to be sufficient to sustain a high biodiversity by their own. Type and species of plants is in this case not as important to biodiversity as the actual connectivity of greenery throughout the city.

Figure 14 Example of a varied landscape with trees in a park. From the botanical garden in Uppsala. Photo: Annika Aspenberg

Air pollution

The green areas in Täby Galopp play an important role in preventing air pollution by a process called phytoremediation. It can therefore be a potential solution for land and water areas within Täby Galopp that are subjected to high concentrations of pollutants such as land alongside roads and Roslagsbanan, or as a method in storm water or waste water management. Phytoremediation can be both a preventative method and a way to deal with point source pollution.

Figure 15 shows that the main source of air pollution within Täby Galopp is the E18 Highway. Data from year 2011 shows annual emissions of greenhouse gases of more than 2265 tons per square km along the highway (Naturvårdsverket, 2014).

Phytoremediation is a method where plants are used in order to remove, detoxify or immobilize environmental pollutants from soil, water and air. Using their ability to concentrate and metabolize elements, both organic substances (e.g. nitrogen and PCBs) and inorganic substances (e.g. led and copper) phytoremediation is an effective method to remediate pollution levels (Salt et al. 1998).

The remediating properties of plants vary between species. Short-rotation Willow coppice is an example of a plant commonly used, since it is both an effective remediate of various pollutants in wastewater and can be harvested as a renewable-energy source (Dimitriou & Aronsson 2005).

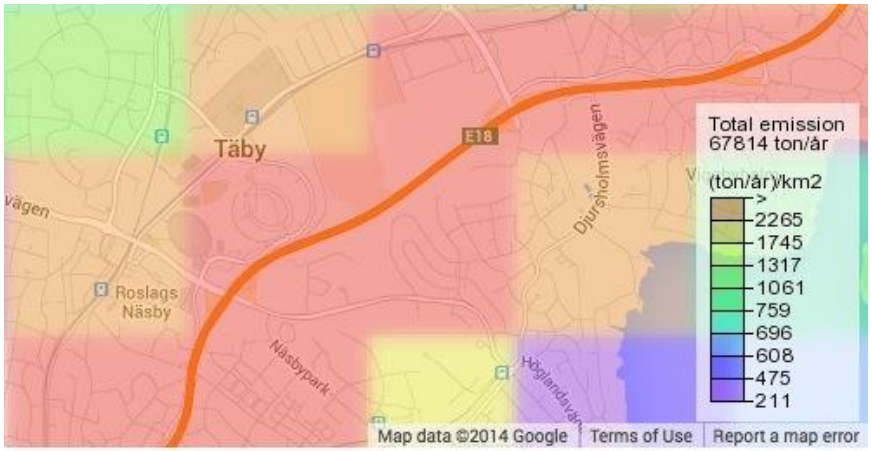


Figure 15 Total emissions of greenhouse gases in tons per square kilometre for the year 2011 in parts of Täby Municipality (Naturvårdsverket, 2014).

Building new infrastructure in the area, both the traffic within and to and from the area will increase. This results in an effect of additional air pollution and a potential increase of local temperature. Roslagsbanan, though not generating greenhouse emissions is still a source of pollution especially small air particles generated from the friction between the trams and the tracks (e.g. iron and copper) (Grüngleisnetzwerk, 2012). Solutions suggested are therefore based on how to use vegetation in order to locally regulate air quality and reduce air pollution within the area from both road traffic and tram tracks.

Solutions for E18-highway

At present stage parts of the area north of the E18-highway are covered by a mixture of coniferous and deciduous forest. Parts of the forest have been identified as important areas for natural values, mainly because of the presence of old pine trees,

deadwood and in some parts broadleaved trees (Calluna, 2013). The solution recommended is to create a green shelterbelt in the southern part of the area, parallel to the highway, stretching from the southwest corner to the southeast corner. This would be accomplished by using existing forested areas and planting a mixture of deciduous and coniferous trees as well as shrubbery in deforested areas. A mixture of species is a favoured alternative (Bolund and Hunhammar, 1999), preferably with a shelterbelt of deciduous forest (Madders and Lawrence, 1985). This is because some species have higher filtering capacity, as well as the length of filtering period while some species are more sensitive to air pollution and better at absorbing gases (Stolt, 1982 cited in Bolund and Hunhammar 1999), especially when they are not exposed to additional environmental stress such as poor soil conditions, wind exposure and competition for light (Madders and Lawrence, 1985).

The aim would be to create a wind permeable belt of vegetation through which traffic polluted air could diffuse before reaching residential & business areas. In combination with the proposed noise barrier this will create a dense green barrier protecting the built up areas from noise and air pollution as well as enabling some wind cover. Other positive aspects might include increased biodiversity and water filtration capacity. The width of this belt will be dependent on amount of available land as well as the length of the suggested ecoduct over the E18 which is approximately 564 metres. The longer the ecoduct is, the less need for air filtration along the highway since it will be more or less covered. The recommendation is to keep the green shelterbelt as wide and tall as possible.

The green shelter belt, a representative of urban vegetation with mainly trees and bushes, can remove a significant amount of air pollution generated within the urban area and thus has the possibility to improve environmental quality, reduce soiling of buildings and benefit human health (Nowak et al., 2006). Depending on the location of vegetation, research has shown that up to 70 % of air pollution can be filtered out by trees in the street (Bolund and Hunhammar, 1999). Reduction of pollutants is primarily achieved by vegetation filtering particles from the air (Givoni, 1991). Pollution levels are also reduced by vegetation intercepting small particles and retaining it on the plant surface. Particles might then be washed of by rain, re-suspended to the atmosphere or dropped to the ground, when vegetation falls to the ground (Nowak et al., 2006). Surface water, such as rain or dew is also considered a sink for air pollutants (Fowler, 1981 cited in Lawrence and Madders 1985). The implementation of this belt should start early in the development process of the area since many tree species are quite slow growing.

Solution for Roslagsbanan

To minimize negative effects of particle pollution to air and surface water, as well as noise pollution from the tramline, a possible solution could be vegetated tram tracks. This will required a high level of cooperation with the SL. The method constitutes vegetation, such as grass or sedum, being planted on the track area (Figure 16).

Figure 16 A tram track vegetated with Sedum plants in Berlin.

Vegetated tram tracks have been successfully implemented in a number of European cities (Figure 17 and 18). A survey show that at the end of 2011 Germany had more than 425 km of single vegetated tracks, which equals a green space of more than 106 ha (Grüngleisnetzwerk, 2012). The municipality of Lund is currently planning to implement green tracks when expanding their tram system (Lund Kommun, 2013). The implementation of green tracks has many potential benefits for both an economical, ecological and social standpoint, some of which are presented below.

- Relief of storm water run-off, which results in less pressure on sewage system and risk of costly overflow in case of heavy rain flow. Tracks can retain between 50-70 % of the annual precipitation falling on the track area giving a 2 km green track a water retention capacity of between 4000-5500 m^3 per year (Grüngleisnetzwerk, 2012).
- Partial uptake of particles by plants and decrease of dust re-suspension in the tracks (Grüngleisnetzwerk, 2012).
- Reduction of maintenance need for ballasted tracks and trains (Grüngleisnetzwerk, 2012).
- Reduced cleaning needs as a result of less waste on vegetated tracks (Grüngleisnetzwerk, 2012).
- Micro-climate regulation by:
    - Reduction of track heating from an average of 50-60° C to 25-30 ° C (Grüngleisnetzwerk, 2012).
    - Increased evaporative cooling (Grüngleis-netzwerk, 2012).
    - Vegetation has less heat storage capacity than e.g. asphalt and also cools down faster (Grüngleisnetzwerk, 2012).
- Noise reduction of up to 3 dB (A) (Grüngleisnetzwerk 2012).
- Influences of green areas on social and mental well-being (Grüngleisnetzwerk 2011).

Figure 17 A tram track in Düsseldorf before greening.

Figure 18 The same tram track in Düsseldorf after greening.

There are certain negative aspects of vegetated tracks mainly related to the cost of implementing them as well as maintenance cost. Climatologically factors such as snow and ground frost might cause additional difficulties. Local conditions must be further evaluated before the choice of vegetation and structure is decided on.

Noise pollution

The green areas in Täby Galopp have an important role in preventing noise pollution. It has been proved that noise pollution causes many different kinds of health problems. Noise is a source of annoyance, stress and even illnesses, such as hearing loss, that may be underestimated in the planning processes. There is still a lack of awareness in both political and social understanding about the negative effects of noise pollution. Implementation and improvement of high-quality acoustic environments are one of the keys for success in urban planning and urban sustainability. In urban areas, noise pollution is mainly caused by traffic on the E18.

By applying ecological measures one can counteract the noise in a sustainable way by buffering the noise pollution at its source (Maleki and Hosseini, 2011). Ecological solutions of noise reduction are categorised as '*regulating* ecosystem services' because they naturally provide environmental quality benefits by decreasing noise levels (Bolund and Hunhammar, 1999).

Unsustainable noise levels in Täby Galopp

Täby Galopp is currently affected by an unsustainable level of noise (from >55dB(A) to >70 dB(A)[3]). There is clearly a fundamental need to resolve the noise pollution by implementing sustainable measures. There are two main sources of unacceptable noise levels[4] in Täby Galopp:

- Highway E18 - Norrtäljevägen (on the south-side) 85 db(A)
- The Roslag Railway - Roslagsbanan (on the north-side) 65 db (A)

The Highway E18 is the main noise issue to resolve; traffic sound created by motor vehicles propagates the exceeding level of 85dB at the source. The second noise problem to resolve in the area is the sound of the Roslag Railway, which is not continuous; the noise pollution level is approximately 60-70dB when the trains pass (Figure 19).

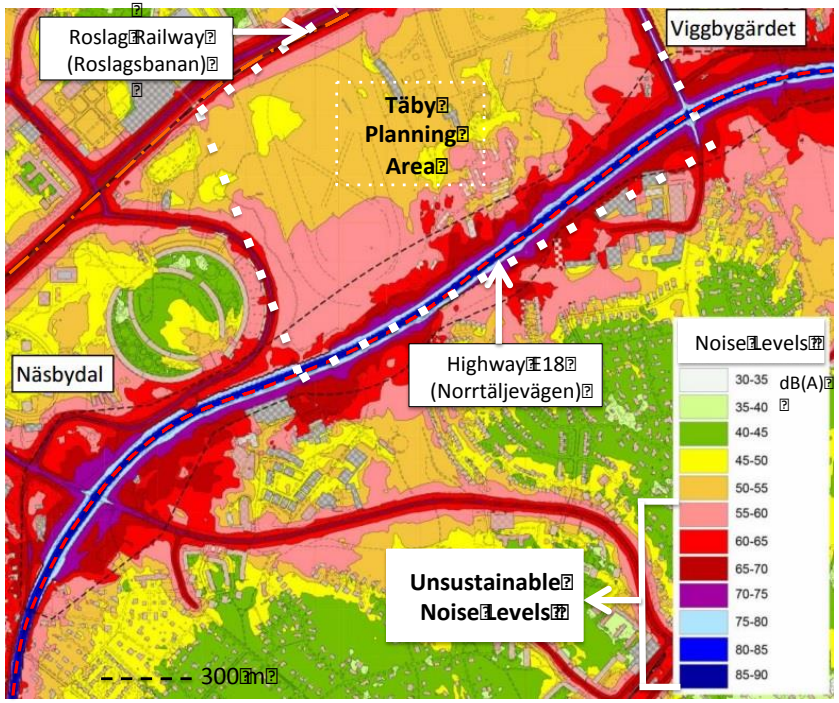


Figure 19 Noise Map of the Täby Planning Area, showing the currently unsustainable levels of noise that are mainly generated Highway E18 (Norrtäljevägen) and Roslag Railway (Roslagsbanan).

Noise reduction planning solutions

Since the different main noise sources need different implementation actions, our plan comprehends of two principal of Noise Reduction Actions:

Noise is a complex phenomenon and travels both though ground and air. Urban soil and plants can attenuate noise pollution through absorption, deviation, reflection, and refraction of sound waves.

Noise Reduction Action n°1

- Construction of an ecoduct/tunnel that cover the Highway E18 (Norrtäljevägen)

Noise Reduction Action n°2

- The implementation of buffer zones of soft grounds, lawns and trees/plants nearby the principal noise sources

"In Sweden, maximum noise level of 55 dB(A) outside and 30 dB(A) inside buildings has been established as the long-term goal" (Bolund and Hunhammar, 1999).

The dB(A) is the standard measure of the noise level; while the Decibel is a logarithmic value, a decrease of 3dB(A) of noise corresponds to a reduction of 50% of the perceived noise. Noise annoyance and its negative effects can be prominently reduced with sustainable planning actions.

In both proposed actions 1 and 2, detailed Noise Reduction Planning Solutions are designed to decrease the unacceptable level of noise. These two priority actions include all kind of green/eco-design structures that have to be applied and structured in the whole surrounding area. Figure 20 helps to localize and visualize where and how the ecological noise reduction solutions will be taken: the numbers (from 1 to 5) are showing their positions while the letters (from 'a' to 'f') are example images of how these measures should be implemented.

By applying together different sustainable solutions of noise reduction as a regulating ecosystem service, outdoor noise levels can be reduced more than 15 dB(A)[2] in areas where noise pollution is too high (Bolund and Hunhammar, 1999).

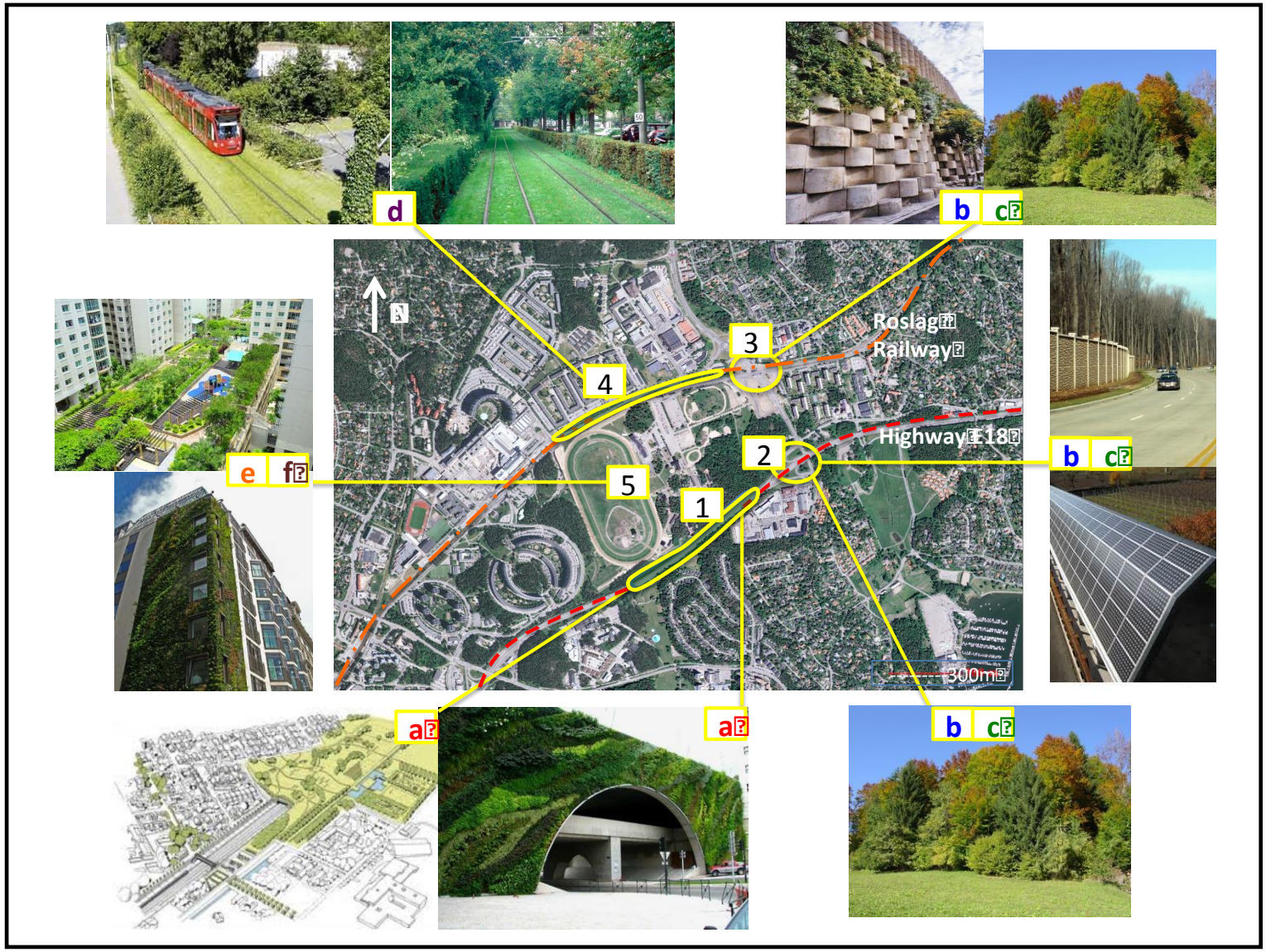


Figure 20 The visualization of the Noise Reduction Planning Solution: 1 to 5 = Locations; 'a' to 'f' = example images of a - ecoduct/tunnel; b - ecological noise barriers and noise barriers with solar panels; c- vegetation buffer zones/rows of trees and bushes; d - lawns and soft grounds; e - soft sound absorption natural materials; f - green roofs.

Table 3 Noise Reduction Plan Solutions (from “a" to "f"): in the table is reported which, where, how and why these ecological solution are implemented in the Täby Galopp Area.

Noise Reduction Planning Solutions (Measures Taken)	Where	How	Why > = gain/increase; < = reduce
a. Realizing the ecoduct/tunnel E1	(1) Above the highway E18	Creating a soil-covered tunnel of 600m that function as an ecoduct with natural soil and plants above it.	To: > Connectivity; > Park size, vegetation and soft ground availability; < Highway visibility; > Ecosystem functions and services; > Environmental quality; > Health and green activities; > Space availability; etc.
b. Establishing ecological noise barriers and noise barriers with solar panels	(2) Along the highway E18 where it is not covered by the tunnel; in the large highway/roads intersections	Using multi eco-materials barriers of wood, stone, soil and native plants; Installing curved barriers with solar panels on their external (south-facing) side.	To: > Ecosystem functions and services; > Landscape value and view; > Renewable energy production; < Synthetic/unsustainable materials; etc.
c. Planting rows of trees and buffer zones of vegetation/bushes	(2; 3; 4; 5) In the ends of the ecoduct tunnel of E18; along the railway truck sides; around the whole area	Using both deciduous and coniferous trees; planting swedish-native willow trees (e.g. *Salix alba*) and native bushes (e.g. *Sambucus nigra*)	To: > Ecosystem functions and services; > Landscape value and view; > Local climate regulation; < The highway and the train visibility; etc.
d. Implementing stretches of lawn and maximizing soft grounds	(4; 5) Within and around the railway truck; In the pavements; around the whole area	Planting grass lawns and infilling soil wherever possible; building soft grounds pavements, paths and roads	To: > Ecosystem functions and regulation services; > Aesthetic value; etc.
e. Using ecological sound absorption soft-materials (e.g. wood, straw, green walls, etc.)	(5) Outside and inside buildings and structures of the whole area	Maximizing and building with wood architectural intrusions (outdoors and indoors) to reduce corner edges; building well-isolated buildings and structures with soft-soundproof ecological materials; Minimizing the use of hard materials and forms.	To: > The sound absorption; > The energy efficiency; > Aesthetic value; < The noise complains of the inhabitants; > The general awareness of noise effects; etc.
f. Realizing Green Roofs and designing and spreading green areas	(5) On the buildings; around the whole area	Putting plants, bushes and soil on the roofs, balconies, gardens and streets; planting and putting plants wherever possible and around sharp-cornered forms	To: > Local climate regulation; > Green space and local values; > Ecosystem functions and services; > Health-green activities; etc.

All these solutions (Table 3) gain the environmental quality with both direct and indirect positive effects; these solutions are implemented to:

- Reduce the noise to sustainable levels
- Built a healthy and pleasant acoustic environment
- Increase all kind of ecosystem functions and services
- Create different kind of ecological values
- Enlarge the available amount of green space and natural habitat all around the area
- Reduce long-term environmental costs and gain the socio-economic benefits
- Increase the aesthetic value of the area

By increasing available natural space for people and animals, the implementation of vegetation and soil to control noise increase substantially the ecological functions such as air filtering/cleaning, storm-water chart control, pollutants absorption, microclimate regulation, and so connectivity, biodiversity, pollination and socio-cultural values are also gained. Furthermore, the use of evergreen species with large foliage is generally advised in this application but it is not always totally possible. More than just solving the noise pollution problem, all the proposed solutions improve the environmental quality impressively.

This approach of noise pollution solving is more qualitative than quantitative but continuous monitoring and measures will be taken, to analyze in detail its effectiveness (Fang and Ling, 2005).

Environmental sounds have complicated dynamics to predict because they depend on weather conditions (also seasons), land-use of space, people awareness/behavior and shape of architectural structures. For example, presence of water bodies and wind can increase the velocity of sound while large amount of snow, vegetation, soil, wood and curved surfaces can attenuate noise propagation. A good noise control policy and participatory or educational projects on noise and soundscape can also impressively increase the general awareness to help the society to create a pleasant soundscape, because those who live in and experience the place, are themselves the "composers" of the surrounding soundscape (Schafer, 1977).

Urban agriculture

The global dilemma

How can we enhance food production and sustainability and at the same time stop expanding conventional agriculture on a global scale?

Täby Galopp's local solutions to the global food dilemma:

- Direct access to food for every citizen
- Resilient food systems
- Ecological production
- Zero transport

- Zero emissions
- Zero pollution of air, water, or soil
- Zero biodiversity loss, but gain

Necessary changes

At present, agricultural land occupies the largest proportion of Earth's terrestrial surface. It increases mostly in the tropics with devastating effects on ecological systems, such as grasslands, savannas and forest biomes. Agricultural expansion and intensification in order to meet the requirements of global population growth as well as a rise of living standards, are leading to the excessive and unsustainable use of water, fertilisers, pesticides and herbicides as well as fossil fuels. All these factors have extensive environmental impacts on a global and local scale, such as an increase of greenhouse gasses, water, air, and soil pollution, biodiversity, and habitat loss. At the same time agricultural areas for food production are decreasing in the temperate zones. In the USA and Europe only 40% of the farmland is used for direct food production and an estimated one third of food produced is never consumed (Foley et al., 2011).

Urban agriculture (UA)
"Urban Agriculture is an industry located within (intra-urban) or on the fringe (peri-urban) of a town, an urban centre, a city or metropolis, which grows or raises, processes and distributes a diversity of food and non-food products, reusing mainly human and material resources, products and services found in and around that urban area, and in turn supplying human and material resources, products and services largely to that urban area" (Mougeot, 1999).

Figure 21 The third step along the horizontal gradient. Agricultural Plots are integrated in the overall design, combining aesthetics, educational and recreational aspects of urban agriculture.

With an area of 7.3 hectares of global average productive space per person, Sweden is amongst the top 15 countries with the largest ecological footprint (Ewing et al., 2010). After forestry with 2.6 ha/person, agriculture makes up for 2.1 ha/person (Lewan, 2000). Due to Sweden's climate conditions as well as consumer demands, a large proportion of agricultural products are produced in other parts of the world and are being imported to Sweden. This adds up to a total of approximately 8% of all national merchandise imports (World Bank, 2004). In 2010, Swedish households spent most of their food budget, which is in average 20% of the income, on imported foods (Swedish Chambers, 2011).

Urban farming in Täby Galopp

Private spaces:

- Roof tops
- Balconies
- Yards
- Front gardens

To be used by local residents of all ages

Public spaces:

- Central Park
- Schools
- Kindergartens

To be used by all citizens including visitors

In accordance to the overall gradient, the areas for urban agriculture will transcend from wild to civil in size and form. Where the forest ends and the open green spaces begin, urban agriculture will be integrated as larger fields with crops such as wheat and potatoes. Further along the gradient, plots will reduce in size and contain smaller and more varied crops, such as lettuce, tomatoes, pumpkins and squash. From being simply turned over soil in the landscape, the plots will have more distinct designs and framings made of natural materials like wood, reeds, and stone. In the city centre (Figure 21) the plots will have distinct bordered beds or even planting tubs.
Also in accordance with the architectural gradient, the urban agriculture will merge into the buildings in form of gardens and green back yards (Figure 22). The more densely built and higher the houses become, the more the UA spaces move from the horizontal position to the vertical (Figure 24) that is on balconies (Figure 23) and on roof tops. Walking through the central park from one end to the other, the visitor will experience not only the variety of landscape, but also the variety of agriculture and crops from small traditional fields via plots and tubs all the way up to the vertical farm.

Food security and employments

Climate change is likely to increase the local growing conditions and studies have shown, that the amount of vegetables harvested on a 10 by 10 meter plot during a 130 day growing season can cover the amount of vegetables needed by one household per year (Brown and Jameton, 2000). The need to import produce to Sweden from other countries where locals suffer from malnutrition and poverty is not sustainable (Foley et al., 2011). By producing a large amount of locally farmed agricultural products, dependencies and overexploitation of developing countries by developed countries could be reduced. The Täby municipality has the opportunity to create new jobs for gardeners and helpers providing the citizens with useful information concerning crops, techniques and schedules for planting and harvesting. Where needed, even practical help in form of assistance and start up kits with soil and seeds are be provided.

Figure 22 (upper left) Organised and tidy, smaller plots are integrated in the Central Park and in back yards.

Figure 23 (lower left) Private urban agriculture on a balcony.

Figure 24 (lower right) Green walls can be installed anywhere in the Täby Galopp area.

Reduced emissions

Urban agriculture contributes considerably to reducing the ecological footprint caused by food imports to Sweden. Private sector food consumption stands for 25% of a total of 80 million tonnes CO_2 emissions caused by food production and transportation in Sweden in 2003 (EPA, 2010). As the produce is farmed in the same neighborhood as it is consumed, there is no need for transport. By enhancing green spaces, especially vertically, urban agriculture can contribute to reducing noise pollution. Furthermore, urban agriculture can promote the uptake, the reuse and nutrient filtering of storm water, thus counteracting the problem of high groundwater levels and eutrophication. The amounts of organic waste from private households can be reduced through composting. The compost can be used for soil improvement and as fertiliser.

Physical Health & Mental Health

Contact with plants and gardening improves overall health and quality of life, and are associated with neighbourhood satisfaction, physical activity, and general health (de Jong et al., 2012). Recreational gardening is known to reduce stress, fear, and anger. It can reduce blood pressure, muscle tension and enhance fine motor skills, which can be especially valuable for elderly and children (Brown and Jameton, 2000).
In Täby Galopp we aim to enhance the quality and quantity of green spaces, thus promoting physical activity and stress reduction. These effects are not only important to residents, but also to the people working in the area. Their workplace attitude becomes more positive when physical and visual access to green spaces is possible (Lottrup et al., 2013). Proximity, active participation and passive indulgence are factors

Figure 25 Lunch talks are fun and provide the citizens with information. New jobs are created in the fields of information and gardening.

increasing the overall health condition. With easy access and the given proximity, the population living and working in the Täby Galopp will experience the opportunity to exercise, see their produce grow in front of their eyes and consume fresh fruits and vegetables.

Community, place identity and safety

Urban agriculture in shared spaces enhances social capital. People of all age groups and backgrounds communicate and work together to achieve a common goal: to produce their own crops, creating neighbourhood networks, a feeling of trust and

decreasing isolation. Getting to know your neighbors contributes to a feeling of safety and reduces crime levels, as people are active outside the closed spaces of their homes and act as "public eyes" (Bellows et al., 2003). By creating and transforming their surroundings, people develop a sense of pride and can identify with their neighborhood (Brown and Jameton, 2000).

As Täby Galopp will be a completely new city built on a more or less naked ground, and all people moving in will be strangers to the region as well as to each other, it is of great importance to integrate variables that allow people to meet, interact and bond (Figure 25). Urban agriculture is such a variable, that in the long run will be an important element in making Täby Galopp a thriving, lively, busy and successful city.

Education

Urban agriculture integrated in the schools and kindergartens has significant educational and health effects. Not only can children learn about the biology of plants and agricultural techniques, they also become familiar with healthy food that is often missing in their daily diets and they are encouraged to exercise in fresh air and receive mental stimulation (Bellows et al., 2003).

With urban agriculture being omnipresent in the area, children will be able to bring home their knowledge and interact with their families and neighbors, which can contribute a sense of feeling safe and at home at Täby Galopp (Figure 26).

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Figure 26 Children from a New York City school farm, where urban agriculture is a part of their education**.**

Drawbacks of urban agriculture

A balance between urban agriculture spaces and green spaces of other aesthetic values like flower arrangements and lawns has to be implemented in the area. However, there is a trend of guerilla farming (a grass root movement, where citizens use abandoned spaces) in Sweden. There are increased activities of urban agriculture in Stockholm. This can be seen on Stadsodling Stockholm, a website representing urban agriculture. The Täby municipality has the opportunity to put Täby Galopp on the map of urban agriculture in Stockholm.

However, a few potential risks need to be addressed. The private use of fertilisers and pesticides are not strictly regulated in Sweden. Uncontrolled use of these substances can contaminate soil and water and should therefore be regulated.

Compost can attract rats and produce unpleasant odors if not installed correctly. But by providing professional help and information the municipality will be able to influence and educate the citizens of Täby Galopp towards a greener, healthier and sustainable future.

Vertical farming

The vertical farm will be a tall building attached to the backside of the grandstand (Figure 27). The upper level of the grandstand will be reconstructed into a greenhouse. There will be space available for cafés and restaurants that can serve food made from agriculture products from the vertical farm. By keeping the grandstand, the cultural identity of Täby Galopp is maintained. The view from this level will be over the square area that contains a food market, restaurants and cafés that sell the produces grown in the vertical farm (Figure 28). A seed bank can also be established giving the possibility for home growers to buy seeds. These features will be the centre of activities and the main attraction of the area. The main streets are therefore all directed to this cultural centre.

Figure 27 The existing grandstand on Täby Galopp. The vertical farm would be attached to the backside of this building. A greenhouse would be made on the top floor behind the windows. Restaurants and cafés in the greenhouse would have a view over the square in front of this building.

Vertical farming

Vertical farming, meaning vertical farm crops that are grown in high buildings on multiple stores, can be seen as the future of agriculture, according to Dickson Despommier (2009). Vertical farming has become a closed loop agricultural technology. Water can be remediated and thus recycled within the system. The nutrients can also be recycled within the system, in contrary to normal agriculture where nutrients are washed out. As water and nutrients are recycled, the only

When you grow crops in a vertical farm you have a year round stable production. By implementing the newest technologies such as PlantLab (PlantLab, 2013), one can optimize the climate conditions for multiple crops, resulting in a great variety of products.

Indoor growing is already a common feature, but it is generally situated outside cities due to the limitation of available land. However, the costs of transportation are high, and transportation means fossil fuel use, carbon dioxide emissions and spoilage. These effects can be diminished by eliminating transportation from the food production system. Furthermore,

the products from a vertical farm can be delivered fresh and with a decreased risk for infectious diseases.

An increase in vertical farming would lead to a decrease of pressure on farmlands. Farmlands might be restored to their natural ecosystems. This is one of the easiest and most direct ways to slow down climate change (Despommier, 2009).

Figure 28 Possible design of a vertical farm.

Positive aspects of vertical farming

Vertical farming is a great opportunity to offer customers fresh produce. By placing the vertical farm in Täby Galopp the inhabitants will be able to buy produce farmed just around the corner (Figure 29). Additionally, the ecological footprint of residents will be reduced.

In order to start the process of establishing vertical farms the government can provide start-up grants and sponsor research centres. Another way is to found partnerships between universities and private companies. Both these choices will create research opportunities for scientists and stimulate education and innovation. A vertical farm generates work opportunities in science, farming, education, retail and catering (Despommier, 2009).

The vertical farm can be link to the municipal wastewater system. The recycled water could be used for irrigation, whilst the remaining waste could be incinerated and used as energy. Another way to provide energy for the farm is using solar panels.

Figure 29 Racks with leafy vegetables grown in a vertical farm. These plants use sunlight. In Täby however it is suggested to use more artificial lights such as LED-lighting, because of the lack of sunlight.

Drawbacks of vertical farming

One of the main critiques on vertical farming is the aspect of financial viability due to the value of land in the city. The funding of the establishing vertical farming could be provided by the government or other investors. Also, the yield of the vertical farm is higher and the costs over time are lower, as it is a closed loop system. This means that the produce from the vertical farm will be able to compete with imported agriculture products.

Another negative aspect is that traditional farmers might lose their source of employment, but they could find job opportunities in the vertical farms. Nevertheless, it could be a positive development if Sweden can become less dependent on imported produce.

Examples of vertical farming

An example of vertical farming is Sky Greens in Singapore (Sky Greens, 2011). Solar energy and captured rainwater is used for a system in which racks with crops are rotated so plants receive an equal amount of sunlight. The Sky Green farm produces leafy vegetables and claims to be 5 to 10 times more productive than traditional farms using conventional methods.
Another example is Plant Chicago (The Plant, 2014), where a ±8700 m² old meatpacking facility is being transformed into a net-zero energy food business incubators. Within the building, vertical farming is demonstrated for the public, educational facilities and sustainable food businesses by providing employment opportunities while being environmentally friendly.

The vertical farm in Täby Galopp would be the second vertical farm in Sweden; the first one is currently under construction in Linköping (Linköpings Kommun, 2013).

SOCIAL CITY LIFE

Green areas and children's health

- Schools and preschools should be placed close to the forested areas to provide easy access to and daily interaction with nature.
- Nature areas, parks and other green elements should be evenly distributed through the whole city district, to ensure easy access and closeness to nature.
- Playgrounds should be designed to provide a diversity of play habitats that include natural elements such as trees, bushes, stones and rugged terrain. (Figure 30)

Health effects

Studies (Fjørtoft, 2001; Grahn, 1997) have shown that playgrounds containing several natural features and some "wild" unstructured areas promote children's physical and mental health, as well as their abilities to be imaginative and creative in their play. Children having daily access to nature playgrounds or a forest had better motor fitness, better concentration capacity and less sick days than children playing in traditional playgrounds (Fjørtoft, 2001; Grahn, 1997).It has also been shown that children diagnosed with attention deficit disorder function better after playing in green areas; the more vegetation the less severe were the symptoms (Taylor et al., 2001) Everyday environments that offer many possibilities for contact with nature and for outdoor play may influence children's health not only in the short term but also in the long term perspective, through forming a base for an active lifestyle. (Mårtensson, 2013).

Qualities and design of playscapes

A distance of maximum 300 metres is recommended to green areas and parks from residences and schools (Boverket, 2013). Distances is usually a problem for children accessing nature playscapes as young children lack the freedom to explore. The location of the playscapes is integral but also the design of the playgrounds is crucial: it can either function as an inspiration for play or as a barrier for the development of play (Grahn, 1997). Children value traditional, designed playgrounds lower than the playing areas they have discovered or created on their own (Peterson, 2012). Traditional playgrounds and playing equipment should thus be seen as starting points for play and to be developed in more "wild" settings (Boverket, 2013). Natural landscapes have several qualities that meet children's need for a varied and stimulating playscape, mainly through having a high vegetation diversity and a varied topography (Fjørtoft and Sageie, 2000). The playscape should therefore provide different kinds of environments, ranging from a culturally defined (man-made) area to a more "wild" and unstructured, natural area in order to offer different play areas as well as spaces for resting. This gradient is a way of giving the children the opportunity to choose their own activities as well as giving opportunities for development. (Grahn, 1997)

Trade-offs

Traditional playgrounds do not always meet children's needs for diverse and stimulating playscapes, while natural playscapes do. In order to achieve an acceptable level of risk in a playscape a balance is needed between security and challenges. High security in a playscape is often equal to a low challenge level, and thus children will find it less stimulating and less attractive to use the area for play. (Fjørtoft and Sageie, 2000).

A nature playground could be either a playscape in the nature, or a designed playground in an urban area that brings natural elements into the city. It can function as an important element for children in cities and as a complement to the traditional playground, as it gives more room for creativity and free movement. (Peterson, 2012)

A tool for assessment of the play potential of outdoor play areas has been developed, called *OPEC* (Outdoor Play Environment Categories), where values are given based on the size, terrain/topography and vegetation as well as the integration between open spaces, vegetation and traditional playground areas. These categories and values have been formed from a children´s play perspective. Children in schoolyards with high OPECvalues have been shown to be more physically active, have better concentration capacity, higher well-being and better sleeping quality. (Mårtensson, 2013)

Social sustainability

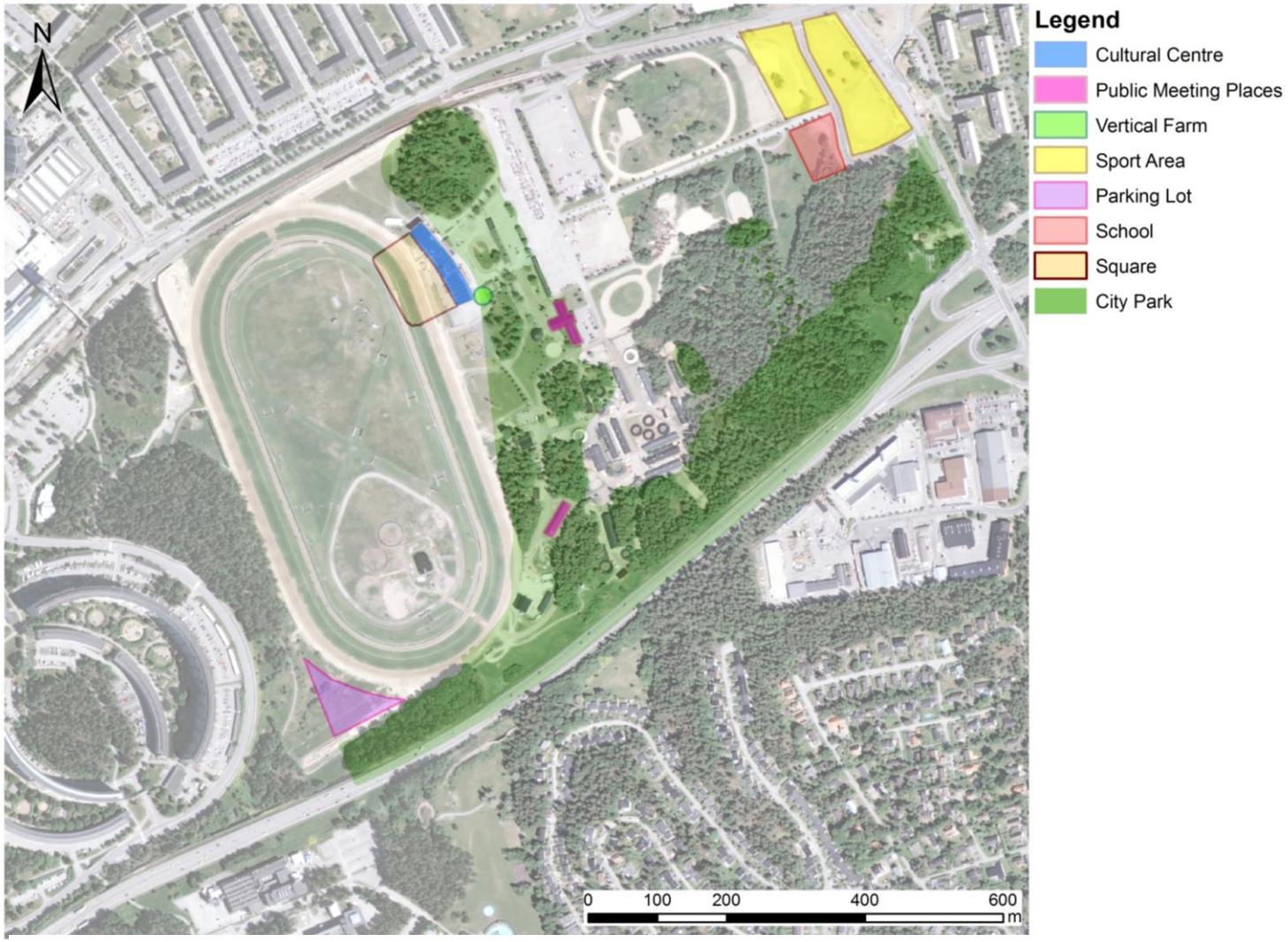

Figure 30 Map of main public areas and meeting places in Täby Galopp.

Social exclusion

Society is constructed by the organization and separation of private and public space. When there is a lack of inclusion in society due to differences in socioeconomic status, culture or religion, there could be negative impacts on the social life of those excluded from society and as a consequence for the society as a whole. Social relationships are being manifested by the use of space (Madanipour, 1998). The exclusion can be revealed in areas such as a closed courtyard which can be used only by a specific group of people.

The structure and design of Täby Galopp should encourage integration and discourage exclusion of residents in Täby Galopp. Small parks and courtyards should have welcoming entrances that are accessible from the street; these areas should also offer a sense of privacy to the inhabitants of the houses. Public areas and parks like the "city park" and the "market square" should facilitate different activities, for example coffee drinking, walking, people watching, picnics, playing etc. The activities should not primarily be based on consumption but rather on experience and socializing. There should be a variation of shops and commercial activities that caters to different groups of people. These activities should be located along the streets to create an open environment that encourages social life in the streets rather than a closed environment in a, for example, shopping mall. Meeting places, places for communal activities like the "horse racing house" and sports halls should be available to everyone. Streets and walking paths should be user friendly and adapted to wheelchairs and prams. The question of social exclusion and social integration are to a great extend a matter of accessibility (Madanipour, 1998), i.e. to which extent individuals have access to public areas and activities.

Housing

Mixed housing is sometimes referred to as a driving force for increased social integration. However, according to a report by The Swedish National Board of Housing (Boverket, 2008) there is no research showing any direct links between mixed housing and social integration. Since the population of Täby mainly consists of age groups 0-19 and 35-54 (SCB, 2014), a mix of rental and private housings with varying sizes could encourage residents of Täby Galopp to remain in the area during different stages in their lives.

Security

The feeling of insecurity can affect the movement pattern of people and their use of the urban environment. Individuals experience security and places differently, depending on factors such as age, gender, ethnicity and disability (Boverket and Infab, 2010). The design of Täby Galopp should be adapted to create a secure environment in order to make the area accessible to everyone.

The green structure, such as small parks and courtyards that are integrated with the built environment is an important complement. The larger coherent green areas may be perceived as insecure and are therefore avoided. Tunnels for pedestrians and cyclists are an example of areas that can also be perceived as insecure (Boverket and Infab, 2010). Tunnels that link Täby Galopp with the centre of Täby should therefore be as short and wide as possible with adequate visibility. All tunnels should be illuminated sufficiently inside and outside and managed for to avoid flickering lights.(Boverket and Infab, 2010).

The use of adequate lighting makes the different areas of Täby Galopp more pleasant for users and residents and visitors can feel secure and use the area of Täby Galopps both day and night. This will encourage a dynamic neighbourhood and a sense of security. Exterior lightning on the facades of buildings, spotlights on trees and on other details in the environment enhances the security of the area. It can give the area aesthetic values and facilitate the orientation in the area (Boverket and Infab, 2010). A possible negative effect of different types of lightning is that residents as well as animals could be disturbed during night time. It is therefore important to use the right type of lighting.

Function mixing

A current vision in the area of urban planning and construction is "The mixed city" (Bellander, 2005). An urban environment with a mix of functions like dwellings, offices, commerce, service facilities and cultural activities, will offer high availability and decrease traffic with greater equality as a result (Figure 30). It will also make the city area buzzing with life during the day, which will make Täby Galopp a safe area. There is a better basis for public transport and services with a dense urban structure. According to Jacobs and Appleyard (1987) there are five characteristics that are necessary for a social life in a city:

1. The combination of liveable streets and neighbourhoods.

2. A density in the residential development and an intensive land use.

3. Varied and mixed activities and functions.

4. A manmade environment with public places defined and enclosed by buildings

5. A large diversity of buildings and places with a human scale and a stimulating urban environment.

The picture in figure 31 illustrates an example of a public space in Stockholm that is characterised by varied buildings.

Figure 31 An example of varied building in a public area in the Old town of Stockholm, Sweden, S*tockholm.*

According to the five characteristics, a dense building structure with the ability to accommodate a variation of functions would be preferred in the area of Täby Galopp. A variation in height, architecture and size would make the buildings and the urban environment exciting and easily oriented. Shops, cafés and other activities should be placed in the ground floors facing the streets with dwellings on the higher floors (Figure 32). The area should not be divided into residential and commercial areas. The main core of the commercial activities can be focused around the market square and Täby Centrum while

some shops are spread out in other parts of Täby Galopp. In this way visitors will have a reason to visit and explore the entire area. There is a mall at Täby centre next to Täby Galopp, this can make it difficult for shops in Täby Galopp to compete with the mall. The area of Täby Galopp should therefore be a complement to the mall by offering something unique for the area. The bridge for pedestrians and cyclists between Täby centre and Täby Galopp is designed to lead visitors to the area of Täby Galopp.

Figure 32 Urban park area showing an example of a variety of mixed functions and social life in Bitola, Macedonia.

An exception to the idea of mixing functions in the plan of Täby Galopp is the buildings for different sporting activities such as indoor tennis or football fields which are located in the north-east corner of the area, next to the school and the already existing hockey hall. However, unorganised sporting activities can be done in the green areas, e.g. the city park. A problem with this kind of multifunctional solution is the risk of residents being bothered by the various activities or the businesses being hindered to function due to residential requirements on, for example, noise levels. A trade off should therefore be made on appropriate activities in the area. There could also be difficulties for the municipality determining on which functions and activities to build for when a majority of the land is owned by private actors.

Place identity

Place identity has become an important factor in the planning for urban areas. There is a variety of definitions of place identity depending on the scientific area and what you incorporate in the definition.

In this report place identity will be confined within manageability and social cohesion (Uzzell et al., 2002). Place identity is the "distinctiveness of a place in terms of buildings, architecture, historical landmarks and other elements of the urban landscape that make the area unique" (Fleury-Bahi et al., 2008). The collective and the individual place identity can be altered or changed all together due to renovations, the introduction of new buildings or other elements (Overgaard and Nielsen 2012).

Creating place identity in Täby galopp:

- There will be a large green area (park) that will go through Täby Galopp from the southern to the northern parts, as shown in the map. There will also be smaller patchy green areas in the southwest part of Täby Galopp that will encompass buildings with living spaces as well as work places.
- Täby Galopp will include historical landmarks such as graves in some of the green areas. This will give Täby Galopp a historical identity, character and also attract people to the parks.
- The park will offer walking and cycling paths, grass areas for picnics and play, nature gyms, ponds and local art, trees and bushes of different heights.
- There will be urban farming all over the area. This will give the local residents a chance to engage in their community and develop social cohesion with others and it will give the area a particular image.
- The Täby Galopp area will have a city like character with distinctive architecture and buildings that set the area apart. The city feeling in itself will contribute to a strong place identity.
- There will be schools, day cares and other community services that make the area manageable and easy to carry out daily activities in. The location can be seen in figure 30.

Evaluating place identity when planning an urban area leads to several benefits. It has been indicated that the atmosphere of a place, e.g. noise, the built environment together with the social and cultural characteristics of the dwellers are important factors to the image of an area and its place identity. A strong place identity leads to the development of social connections and the satisfaction of living in a certain area (Fleury-Bahi et al., 2008). The social aspect of place identity is something we need take into consideration when planning Täby Galopp in regard to street structures, architecture, green areas such as parks and smaller patches of greenery. One obvious benefit of green areas is the use of them as meeting places which will enhance the social bond to other residents and therefore the grade of place identity.

Figure 33 Urban park area showing an example of a mixture of nature elements such as water, trees, bushes and different levels.

The context of physical and mental health in urban planning should also be considered. According to the World Health Organization (WHO) stress and physical inactivity are the main

causes of death in the developed parts of the world(WHO cited in Grahn and Stigsdotter, 2010). It is therefore crucial to aim toward planning for decreasing health issues in Täby Galopp through the planning of green areas. (Grahn and Stigsdotter 2010). A key question in this context is how to encourage people to visit green areas like parks in order to receive health benefits. Examples of factors that increase the ability to perceive green areas as positive are: *Nature*, i.e. how you experience nature. R*efuge* i.e. green areas where visitors partly can be active and feel safe and that include areas secluded by trees and bushes. S*erene,* i.e. that the area is not too noisy, littered or crowded (Grahn and Stigsdotter 2010). This also relates to the question of place identity in terms of manageability. If the residents of Täby Galopp can visit green areas that fulfill the requirements (Figure 33) stated above then that should contribute to a positive connection to the area and also project a positive image to Täby Galopp.

There is also an economic perspective on the question of green urban areas. The remediation of noise, air and water pollution through the incorporation of urban greenery will increase the market value of an area. An example of this is, Milaniries in Budapest. (Balogh and Takács, 2011). This process will also contribute to a strong sense of place and attract residents and economic activities.

Consequently, green areas appear to have a positive effect on place identity (Figure 34) but there is a need for further research on the connection between place identity and green urban areas. There are possible negative effects of a strong place identity; studies show that unkempt green areas are perceived as a threat (Tzoulas et al., 2007). This means that green areas need to be managed by the municipality. An additional way to avoid unmanaged or littered parks is to establish green areas as an important element of place identity in Täby Galopp. Another possible negative affect of creating an area with a strong place identity is that it might not fit in to the identity of the rest of Täby, which is why it is important while planning for a strong place identity to consider surrounding areas.

Figure 34 Example of a city park in a dense urban area.

Individual residential and office buildings

Sustainable materials

The construction industry in the EU accounts for 40% of the total environmental burden in the European Union (Rice, 2007). Approximately 30% of CO_2 emissions on a global level are attributed to buildings (UNEP, 2009). In recent years, energy efficient buildings such as zero-energy buildings have received increasing attention as the implementation of the EU Directive on Energy Performance of Buildings imposed requirements regarding the emissions of member states. The Directive requires that by 2020 all new buildings should be "nearly zero energy buildings"(EU Directive, 2010).

What needs to be changed?

- Increasing use of types of materials which are good for human health and the environment
- Increasing environmental concern during construction phases
- Increasing energy-efficiency in buildings
- Increased planning for sustainability (System perspective, Life-cycle analysis, zero-waste concept)

In terms of environmental impact the primary focus is on buildings' direct energy consumption (heating, ventilation and household electricity). This is the common way of relating to energy consumption in the "sustainability project" such as, the Royal Seaport in Stockholm (Wangel, 2013).However, the energy consumption during the construction of this district is not included. Recent studies show that the environmental impact of the construction phase is now larger than that from the heating of buildings in Sweden. This suggests that the energy consumption during construction phase should not be left out when calculating the total energy consumption. This refers to emissions from the extraction of raw materials, manufacturing, transportation and installation of building materials during the construction, maintenance and alteration of a building (Toller et al., 2011).

Energy efficient buildings

Each country has its own definition and standard for an energy efficient building related to the local climate and economy. Energy efficient buildings can be defined as buildings, designed to reduce energy consumption to a lower level. Examples of different types of energy-efficient buildings are: Passive House, Low-energy buildings, Energy self-sufficient houses and green building.

When and where?

Requiring energy efficient and sustainable buildings should ideally take place early in the planning of Täby Galopp. It is also advantageous to adopt a system approach, with a life-cycle perspective in the planning, analysing the environmental burden of buildings throughout the lifecycle. It is also essential to consider how information exchange between different actors can be coordinated. Ideally, environmentally friendly materials and energy-efficient buildings should be considered in throughout the area of Täby Galopp with regard to residential buildings, offices, malls, schools

Another important aspect is the effect of material choice on the total energy need and recycling potential of a building. Minimizing energy consumption, use of natural resources and maximizing recycling is a priority in sustainable construction. For example, over 50% of resources taken from nature are related to the construction sector. The importance of reducing the building's energy consumption has increased the development of energy-efficient construction. Approaches and guidelines should therefore help to reduce the building's energy consumption and greenhouse gas emissions by designing all parts of the building to be energy-efficient. For example, envelope (roof, walls, windows and doors), heating, ventilating and air conditioning systems, lighting, and equipment (Thormark, 2006).

Chemicals

The Swedish Environmental Quality Goal (EQO) ”Non-Toxic Environment" was a starting point for the area of chemicals in the environmental classification system. Several different systems that aim to evaluate construction materials, which may be useful for monitoring the environmental impact of the construction industry, have been developed. These systems are based on criteria of environmental and hazardous properties of substances. One example is the BASTA system, which aims to phase out hazardous substances from construction (Toller et al., 2011). The Täby Municipality has an excellent opportunity to require materials free from toxic chemicals and environmental classified buildings to protect nature and human health.

Planning for sustainability

Sweden has a customer driven policy on energy and materials in buildings. Therefore construction relies more on market conditions than on regulations. So far, there are no major initiatives to use energy as a competitive offering, meaning that it

What is life cycle assessment?

Life cycle assessment is a tool to assess the environmental aspects and potential impacts associated with a product, process, or service, by compiling an inventory of relevant energy and material inputs from cradle to grave. In the life cycle assessment of buildings, this includes environmental impact from materials, construction phase, and transport besides actual energy use in buildings.

is the customer's request that drives the development of energy efficient buildings (Schade et al., 2013).

The Täby Municipality has a vision related to environmental performance of buildings within its environmental plan, especially in the case of "A Good Built Environment", which indicates that the buildings must be constructed and maintained so that resource-efficient solutions are promoted and recycling of materials will increase (Täby Kommun, 2009). The dialogue with citizens concerning development of Täby Galopp revealed a great public interest in energy-efficient housing (Täby Kommun, 2013f). To meet this requirement, there is a need to call for a life cycle assessment in the planning process and decision. (Wibke et al., 2010). The municipality of Täby has an opportunity to show how "real" sustainable buildings and cities can be constructed. Reducing the amount of waste is also an important part of sustainable building. (Kotaji et al., 2003).

Positive and negative effects of using life cycle perspective on sustainable materials

A life cycle perspective in planning and decision-making is an effective tool to identify negative environmental and health effects in the building process (Figure 35). However, due to the complexity of the construction process and the long life of buildings, it can be difficult to predict the full life cycle from product conception to final life stage (Zalejska-Jonsson, 2012).

Correct design and use of materials in buildings and constructions are necessary in order to reduce the environmental burden. Architects who make decisions about the final planning do not necessarily have environmental know-how about production processes or resources used as construction material. It is a great opportunity to collect input

Figure 35 Building Life Cycle Cradle to Grave. Generally only the usage stage is taken into account in spatial planning and a majority of environmental impact is excluded. This is something that can be changed by using a Life Cycle Perspective

from different experts in order to capture the whole picture of the life-cycle of buildings (Wibke et al., 2010).Besides lowering energy use and CO2 emissions, energy efficient buildings give additional positive effects, such as improving social welfare and indoor air quality (Rice, 2007).

Energy efficient buildings are often considered as a good investment opportunity and both residents and businesses can take advantage of the potential to save energy. The extra initial cost of energy-efficient buildings is generally covered in the long term due to energy savings (Zalejska-Jonsson, 2012).

If Täby municipality is eager to fulfill their goal "Good built environment" and include all emissions and energy use, a lifecycle perspective would be an excellent tool during the planning process and design of Täby Galopp (Khasreen et al. 2009; Wibke et al., 2010).

Solar energy

The European Union stipulates that energy used in the built environment should be reduced with 41% by 2050 (Wallin et al., 2012). According to Kanters et al. (2013) architects can contribute to an energy-efficient built environment when they make key decisions early in the building process.

Figure 36 Solar panels on a noise wall in Germany.

The Energy Performance of Buildings Directive also requires all the new buildings from 2020 to be nearly zero-energy buildings, which means that the buildings need to generate energy. This can be achieved by using solar energy. Architects should be involved in the early stages of the planning process for solar panels since it is necessary to have enough space for the panels and planning of too many flats may hinder that.

In order to reduce noise pollution from the E18 in the area of Täby Galopp, a sound wall will be put up along the motorway. Since the sound wall is facing south, solar panels should be installed on the wall. This will be a suitable addition to the solar panels that will be placed on rooftops of the buildings in the area, in order to partly fulfil the energy need of Täby Galopp. An example of how to implement solar panels on the noise wall is shown in figure 36 where panels in three rows have been put up.

In figure 37, four different types of building structures are shown. Kanters and Horvat (2012) made investigations concerning the energy that could be extracted with different kind of building structures (shading plays a big role in energy extraction from solar panels). All different factors taken into account, type A was the most efficient one. When planning for the buildings in the Täby Galopp area, it is therefore important to look at the structure of the buildings and where to put them.

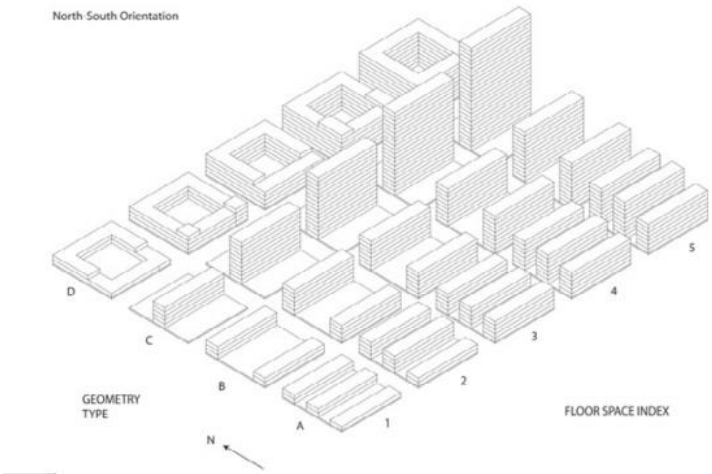

Figure 37 Four different types of architectural structure.

Alzoubi and Alshboul (2010) also bring up voids between apartments that risk affecting exposure of the buildings to the sun. This could be avoided by having an effective design that benefits from the sun's heat; in addition to this, when it is colder there is also the benefit of heating from the direct sunlight.

Energy efficiency

The buildings in Täby Galopp should be passive houses, i.e. houses that require low energy consumption, or plus energy housing: self-sufficient buildings may consequently have electricity to sell. To achieve this, the walls and windows should be well sealed, and the ceiling of the attic should be filled with loose cellulose. It is necessary to consider what type of window is suitable in terms of energy efficiency (Stecher and Allison, 2012). The house itself is also a source to energy efficiency. The building structure and the location of the houses will affect the use of solar panels in regards to using direct sunlight (Hoffman et al., 2014). During cold periods for example, big windows facing south and smaller windows facing north helps saving energy (Hoffman et al., 2014). In today's housing there is a lot of heat that disappear due to ventilation; with a heat exchanger, however, the energy can be conserved by using the extracted heat to warm up the incoming cold air (Gendebien et al., 2013). This saves a lot of energy.

Promoting sustainable lifestyles

Environmental problems are the consequence of human behaviour and therefore solving environmental issues involves behavioural change (Schultz, 2013). Many people doubt the effectiveness of small simple efforts in favour of the environment. However, if everyone took a little effort, it would create a significant positive environmental impact (Osbaldiston anf Schott, 2011). American scientific research has proved that emission reduction, which can be achieved by reasonable interventions in 17 everyday household chores, can reduce carbon emissions with 123 million metric tons per year for the USA. This is roughly 7% of the US national emissions without compromising household well-being (Dietz et al., 2009).

But how exactly can this reasonable change in behaviour be promoted and achieved for Täby Galopp? Scientific literature comes up with 9 general types of strategies, according to Osbaldiston and Schott (2011), which will be explained in the following and accompanied by several useful examples which can directly by implemented in the whole project area.

Strategies based on convenience

1) **Making it easy**: changing situational conditions in order to make it easier to behave sustainably, for example:
   - Moving recycling bins to a more convenient location: having the appropriate opportunities and facilities to recycle is the major factor of pro-recycling behaviour (Tonglet et al., 2004).
   - Reserve the best parking lots for carpooling.

2) **Prompts**: notes or signs to remind people when to perform specific activities without giving any more information, for example:
   - "Put recyclables out tomorrow." (households)
   - "Turn lights off when leaving room." (public buildings, schools)
   - "Turn of computers after use." (public buildings, schools)

Strategies based on information

3) **Justifications**: spreading of information on reasons why to perform in a specific way, for example:
   - Table top signs in private and public restaurants (e.g. school and office cafeterias) explaining the benefits of composting.
   - Signs to use the stairs instead of the elevator.
   - Public information campaigns e.g. about speeding to inform that it is dangerous and wastes fuel.
   - Pamphlets, websites and movies.

4) **Instructions**: Procedural information to indicate how to perform the preferred energy-conserving behaviour which has a significantly positive effect on people's behaviour (Bator et al., 2014). To maximise the impact of information, it should be easy to understand, trusted, attracting attention, easy to remember and as close as possible in time and space to the relevant choice (Froehlich et al., 2010), for example:
   - Signs above compost and recycle bins in public and private restaurants on how to separate your leftovers. However, pro-environmental example actions by others are more effective in influencing similar behaviour in people than signs are (Sussman and Gifford, 2013).
   - "Use the blinds to reflect the sun to keep the office cooler." (Osbaldiston and Schott, 2011)

Strategies focused on monitoring

5) **Feedback**: providing information on the extent to which a behaviour has been performed by participants in an earlier time-frame (Osbaldiston and Schott, 2011). Feedback generally results in typical energy savings of 5 to 12 % (Froehlich et al., 2010). For example:
   - The most common eco-feedback designs is a common LCD display or a bar chart showing historical usage data, mainly related to energy use (Figure 38) (Froehlich et al., 2010).
   - Feedback on energy use in homes with the optimal placement of energy monitors near the main entrance door allows residents to check usage before leaving, but it also lets visitors notice the technique and possibly adapt it or at least start a conversation about it (Ela, 2008).
   - Personalised energy feedback to office workers by a new system using wireless techniques calculating the energy-use caused by specific behaviour based on the location. This helps employees to identify energy reduction opportunities. However some issues still exist for implementing feedback in work places: technology issues (frequent need to recharge the measuring equipment), time intensive, limitations in reductions by high-energy consuming equipment from the company and ethical issues such as privacy, surveillance and misuse of data (Coleman et al., 2013).
   - It is possible to display your eco-feedback with a personalised design because every user has different environmental concerns and motivations to conserve energy (Figures 39 and 40) (Petkov et al., 2012).

Comparison between individuals and groups is particularly effective in the eco-feedback technology to promote sustainable behaviour (Ela, 2008; Ferguson et al., 2011; Froehlich et al., 2010; Toner et al., 2014), for example:

- Include local average usage on energy or heating bills. It is more useful to calculate averages for local and homogenous billing communities, like a single block or per apartment building, rather than city wide averages which would include a wide range of social classes and lifestyles (Ela, 2008).

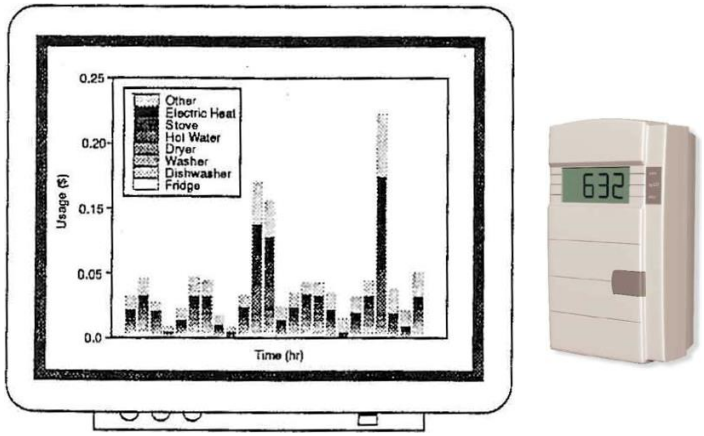

Figure 38 Two of the most common eco-feedback designs in environmental psychology: right a simple LCD display; left a bar chart showing current and historical usage data.

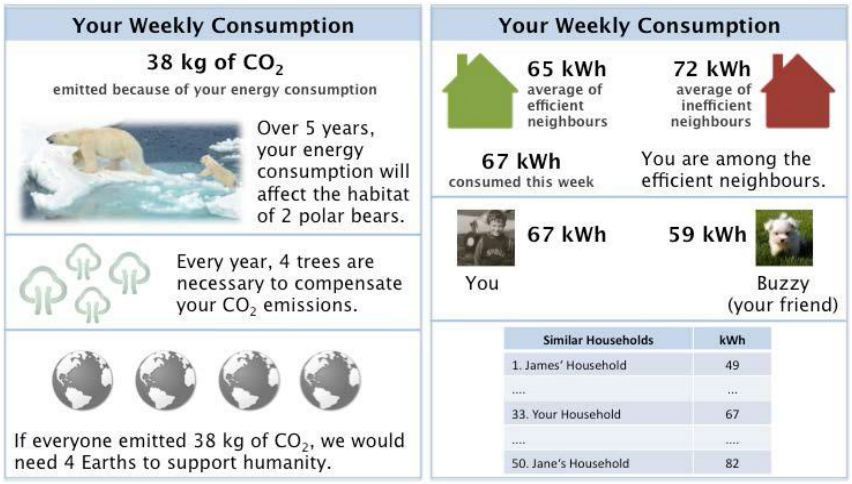

Figure 39 Egoistic energy use feedback display (left) and altruistic (right).

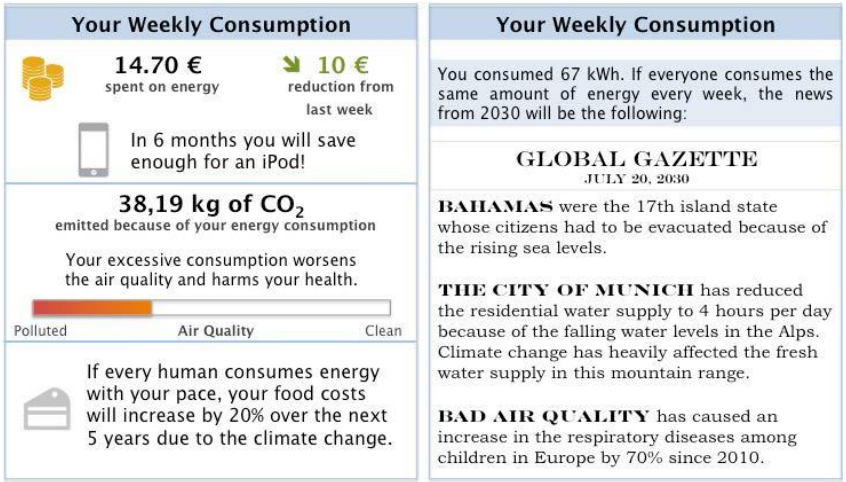

Figure 40 Biospheric energy use feedback display (left) and social display (right).

6) **Incentive/disincentives and rewards/penalties**: incentives/disincentives come before action and are therefore antecedent motivation strategies, while rewards and penalties come after action and are therefore called consequence motivation techniques (Froehlich et al., 2010). All four strategies can involve money or status related gain and setback like cash, coupons, reductions, bus passes, gifts, prizes, taxes… or simply public acknowledgement (Schultz, 2013).

   One example of a disincentive to reduce overconsumption is an increase cost of resources by taxes, for example environmentally-based taxation scheme for garbage and fuel (Brown and Cameron, 2000).

   - Regulations and property rights are strong disintencives often combined with penalties if they are not followed. Local laws: for example creating anti-idling areas in busy places like schoolsor transit stop, this way it would target the largest concentrations of idling-emitted emissions (Ela, 2008).
   - Investment subsidies for home insulation, solar panels, low-flow shower heads and other energy and resource saving equipment are strong incentives (Froehlich et al., 2010).
   - Reducing taxes for fuel-efficient or electrical vehicles (Dietz et al., 2009).

Strategies based on social-psychological processes which involves people interacting

7) **Social modelling/norms/diffusion**: informing people via demonstration or discussion in which initiators indicate that they are also personally engaged in the specific behaviour. Community-based organisations stimulate sustainable lifestyles among their participants because they provide new organizational and structural resources, new cultural rules and new Figure 4: Model of sustainable lifestyle change in community: how change in lifestyle occurs in the context of interventions by community-based organisations. Source: (Middlemiss, 2011).

   - Personal resources from other participants which may have an impact on lifestyles when a change occurs in the participant's understanding of values (see figure 4) (Middlemiss, 2011).
   - Initiatives generated bottom-up by consumers instead of top-down by agencies or companies like economic boycotts of unsustainable products (Brown and Cameron, 2000).
   - On-the-job training: providing a supportive, social teaching environment for employees with the introduction of new habits and techniques, while demonstrating the available cost savings, may indirectly

Overconsumption is the overutilization by society members of a shared basket of resources (Brown and Cameron, 2000).

change the behaviour employers at other places like at home, e.g. how to use software energy efficient, shutting off computers, taking the stairs, plug-in electricity monitors, and smart power strips (Ela, 2008).
- A local competition, for example in lowest household energy use, would increase discussion about energy saving and energy saving methods. For this some kind of general feedback system is necessary in the whole area (Ela, 2008).

8) **Commitment**: Request participants to make some kind of verbal or written pledge to engage in a behaviour which leads to behaviour change in short- and long term (Lokhorst and Werner, 2011), for example:
   - A signed pledge for recycling or gas and electricity saving (Froehlich et al., 2010).
   - A verbal pledge to lower the thermostat temperature with one or several degrees (Dietz et al., 2009).

9) **Setting goals**: Request participants to aim for a predetermined goal which can be linked to rewards and which is an especially valuable strategy when combined with feedback (Froehlich et al., 2010), for example:
   - Reducing household electricity consumption by 20% (Osbaldiston and Schott, 2011).
   - Line drying instead of using the drying machine and washing laundry with a lower water temperature (Dietz et al., 2009).

This list of measures to improve sustainable lifestyles is useful for the municipality, companies, public building, organisations and households once living or working here. However several aspects of it can and must be done now, spatially in the planning stage of Täby Galopp, hands-on by the municipality:

- Make sure people of Täby have access to information about sustainability if they want by establishing help lines for information like an internet platform, providing a Täby Galopp Newsletter to households, organise information evenings with lectures from experts, documentary evenings, discussion evenings on municipal views or decisions…
- Orientation program for new inhabitants to get to know the sustainable profile of Täby Galopp and to encourage sustainable lifestyles to them by offering opportunities to subscribe in carpool programs, join community organisations, offer a free monthly SL-card to include public transport in their daily routine…
- Install information points of measurement and display of CO^2-emissions and ground-ozone levels on the parking lot in the south east near the E18, on every bus stop and in the park to indicate the difference between those spaces. There should also be a feedback display of energy use in every public building.
- Establish requirements for every single apartment built in Täby Galopp and for every workplace created to be equipped with a user friendly system for measurement and visualisation of energy and water usage.
- Provide spaces and opportunities for bottom-up activities like urban farming, environmental organisations, lunch talks on environmental or community issues, composting, neighbourhood swapping or second hand market… These spaces can be found in the park, in the cultural centre, in the scientific centre and in other buildings throughout the whole site.

DISCUSSION AND CAUSAL LOOP DIAGRAM (CLD)

The purpose of the project has been to plan Täby Galopp in a sustainable way from an ecological, social and economic perspective. In practice this is very difficult to achieve due to the high complexity of modern day society. Different factors affect each other, and together they form a system structure as presented in the CLD (Figure 41). The three perspectives are equally weighted in terms of importance when it comes to achieving sustainability in society. The focus throughout the project was to show the importance of the green areas for the wellbeing of humans and nature. Society benefits from a healthier population with fully functioning ecosystem services. Some attention has also been given to the layout of the built environment and its impact on social life, efficiency of transport and resource utilisation, which in turn will affect the social as well as the ecological and the economic sustainability. The complex system that society constitutes, however, involves many conflicts of interests.

The main conflict within this project is between the green and the built up areas; since exploitation of the project area results in less green space. Consequently, to fit the number of residences and work places that Täby municipality demands, a balance of interests must be met. We are convinced that the gradient concept is a viable solution to this matter. Dense building structures within the assigned areas will decrease urban sprawl and ensure conservation of green areas in other parts of Täby municipality. Additionally, it will provide a new social hub which is easily accessible.

The increase in the number of people using the neighbourhood positively correlates with adverse effects on the environment. Therefore, thoughtful planning to reduce environmental impacts is essential for Täby Galopp in order to create a sustainable neighbourhood. Measures and technologies may be in some cases costly, but will provide long-term profit by the reduction of expenditure associated with socially, environmentally and economically unsustainable processes.

One important condition for a sustainable society is an environmental friendly outlook from the citizens. To achieve this, sustainable choices should be encouraged via informing inhabitants and commuters about how to live a more sustainable life.

To summarise, the main focus when planning for the area should be a variation of sustainable measures in regards to the growth and well-being of the physical, social and economic environment. The project was devised with the promise to inspire and innovate new concepts concerning the development of Täby Galopp.

How to read a Causal Loop Diagram (CLD)

A Causal Loop Diagram aims to show how different variables of a problem are interconnect and affect each other in a way that otherwise might be difficult to identify. It is used to communicate the complexity of a problem by showing the system dynamics. The systems consists of different variables that affect each other. The arrows are used to illustrate this:

- **A plus sign (+)** at the end of an arrow means that the change for the connected variables happens in the same direction. For example the positive (+) connection between "Biodiversity" and "Variation in design and diversity of green areas" (Figure 41), where an increase in "Biodiversity" would lead to an increase in "Variation in design and diversity of green areas". In the same sense a decrease of "Biodiversity" would lead to a decrease in "Variation in design and diversity of green areas".
- **A minus sign (-)** means that the change for two connected variables happens in opposite direction. For example the negative (-) connection between "Car use" and "Use of public transport" (Figure 41). An increase in "Car use" would lead to a decrease in "Use of public transport". As well as a decrease in "Car use" would give an increase in "Use of public transport".

If there is a **feedback** between two variables or more (a loop), the feedback mechanism is illustrated by a **letter** in that loop. When a loop is reinforcing, a positive feedback, it is symbolized by the letter R as well as a loop arrow showing the direction of the reinforcing behavior. A loop can also be balancing, which means there is a negative feedback. In that case it is symbolized by the letter B with the loop arrow.

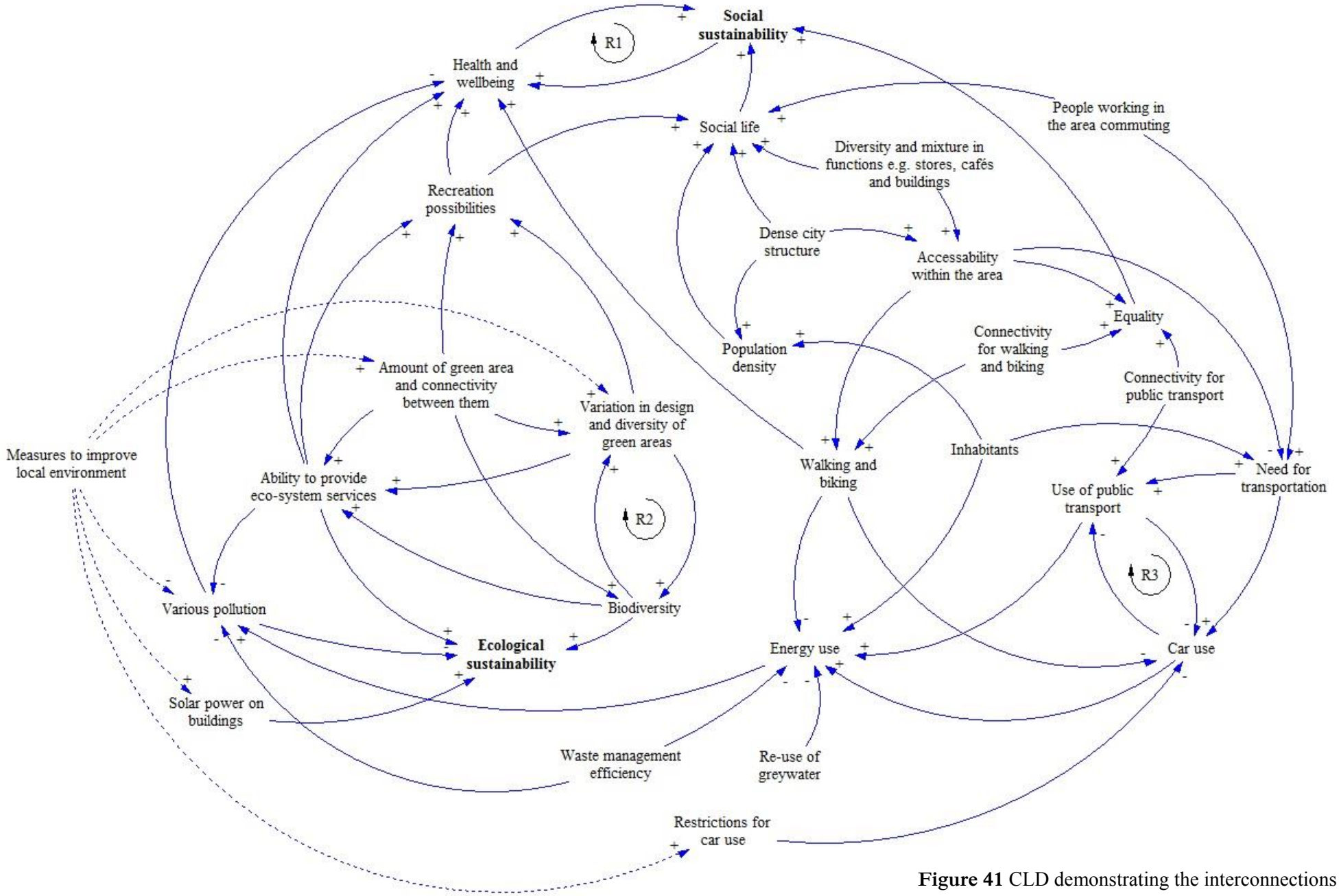

Figure 41 CLD demonstrating the interconnections and correlations between different elements in Täby Galopp.

CONCLUSION

The suggested plan for Täby Galopp is designed to meet the environmental goals set by the government and the municipality (cf. supra section 1. Introduction) and further strives to ensure an environmental, economic and social sustainable future of the planned area by:

- Reducing noise and air pollution by the presence of green areas, ecoducts and sound barriers
- Enhancing provisional, supporting and cultural ecosystem services by the presence of green areas, such as green roof tops, urban gardening spaces and the city park
- Enhancing the mental and physical health of its residents by the presence of accessible green areas, for instance the city park, walking and biking possibilities and sporting facilities
- Preserving biodiversity by the presence of green areas, such as the city park and urban gardening spaces
- Increasing connectivity with surrounding green areas by the presence of ecoducts and green corridors
- Ensuring conservation of areas with high biological values
- Increasing water filtration by the presence of streams and wetlands and further counteracting water pollution by using biofilters
- Preventing flooding by planning for open storm water systems and constructing wetlands, dams, streams and ponds
- Ensuring the usage of recycled materials, for example by using recycled asphalt
- Ensuring the cultural identity and sense of place by preserving and converting existing structures, such as old stables, preserving old grave sites and restoring the original valley landscape
- Ensuring a lively city environment by planning shops, cafés, public greenhouses, restaurants and public meeting spaces
- Maximising the residents' usage of public transport by adding bus stops in the area
- Minimising car use by restricting cars in the city centre and by offering biking and walking lanes throughout the planned area
- Maximising the produce of locally produced and organic greens by the vertical farm and urban gardening spaces
- Ensuring the area's attractiveness for people in all age and social groups by planning for schools, kindergartens, senior citizens' homes and further planning for housing in various sizes
- Providing a sense of community and encouraging integration by planning for small parks and courtyards in between housings
- Reducing climate impacts by using renewable energy in the form of solar cells on roof tops and by building energy efficient housings

The main objective of the plan is to promote a sustainable lifestyle for its future residents and to endorse awareness in regards to local and global sustainability in environmental, economic and social terms related to urban planning.

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Figure 21 The third step along the horizontal gradient. Agricultural Plots are integrated in the overall design, combining aesthetics, educational and recreational aspects of urban agriculture. www.eyeonauckland.com/2011/07/eye-on-aucklands-vision-for-auckland

Figure 22, Organised and tidy, smaller plots are integrated in the Central Park and in back yards. www.inspirationgreen.com/wattle-edging.html

Figure 23 Private urban agriculture on a balcony. www.au.timeout.com/sydney/aroundtown/events/30961/urban-farming-and-balcony-gardens-workshop

Figure 24 Green walls can be installed anywhere in the Täby Galopp area.: www.pinterest.com/pin/445504588109008571

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Figure 26 . Children from a New York City school farm, where UA is a part of their education. http://www.thebattery.org/projects/battery-urban-farm/youth-education

Figure 27 The existing grandstand on Täby Galopp (Aspenberg, A. 2014)

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