Hammarbyskogen

A report from the course Case Studies of Environmental Impact Assessments 15 credits, AT 16
Department of Physical Geography

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Foreword

This report is the result of a project work within the course *Case studies in Environmental Impact Assessment* at Stockholm University. The course is a mandatory part of the Master programme *Environmental Management and Physical Planning* at the Department of Physical Geography. This programme is multidisciplinary with both Swedish and international students. The course comprises 15 HEC, i.e. ten weeks of study. The project part covers five weeks with the aim to give the students an opportunity to analyse the environmental impact of a planned project and to get some practice in how to make an Environmental Impact Assessment.

This time we have chosen to study the environmental impact of plans on new residential areas in the Stockholm region. The population in this region is expected to increase rapidly, according to the Regional Development Plan with more than 900 000 inhabitants to the middle of this century. Thus there is a great need for new apartments to be built. However, this could mean a negative impact for some valuable green areas around Stockholm. Many of these areas are important for biodiversity and for recreation. To analyse these conflicts and to suggest mitigation measures have been an important task for the students in this project.

The students alone are responsible for results and conclusions in this report and it can not be regarded as the position of Stockholm University. The project supervisors have been Salim Belyazid, Bo Eknert, Peter Schlyter, Ingrid Stjernquist and Johanna Gordon, all from the Department of Physical Geography.

We want to thank all those who have been helpful in providing the students with information and materials as well as have taken time to give interviews. Without your help this project could not have been realised.

Stockholm, January 2017
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List of Actors

Act Relative to the Transportation of Dangerous Goods - Förordning om transport av farligt gods

Culture and Recreation Committee- Kultur- och fritidsnämnden, Sundbyberg

Culture Committee- Kulturnämnden, Stockholm Stad

County Administrative Board - Länsstyrelsen

City Planning Office - Stadsbyggnadskontoret

City Planning Committee- Stadsbyggnadsnämnden

Environmental Administration - Miljöförvaltningen

Stockholm County Council - Landstinget

City Museum of Stockholm - Stadsmuseet

Stockholm Stad, Municipality of Stockholm - Stockholms stad

City Council - Kommunfullmäktige

Municipal Executive Committee - Kommunstyrelsen

City District Administration - Stadsdelsförvaltning

Cultural Heritage Law - Kulturmiljölagen

Traffic Office - Trafikkontoret

Swedish Transport Administration - Trafikverket

Swedish Transport Agency - Transportstyrelsen

Swedish Environmental Protection Agency - Naturvårdsverket

Swedish Environmental Code - Miljöbalk

Swedish National Heritage Board - Riksantikvarieämbetet

Swedish National Land Survey - Lantmäteriet

Swedish Society for Nature Conservation Naturskyddsföreningen

Swedish Civil Contingencies Agency - Myndigheten för Samhällsskydd och Beredskap

National Board of Housing, Building and Planning - Boverket

Development Committee - Exploateringsnämnden

National Board of Health and Welfare - Socialstyrelsen

Technical committee: Tekniska nämnden

Land and Environment Court of Appeal - Mark- och miljööverdomstolen

Svea Court of Appeal - Svea hovrätt
Heritage Conservation Act - Kulturminneslagen

Development Administration - Exploateringskontoret

The Greater Stockholm Fire Brigade - Storstockholms brandförsvar

Glossary

Accessibility	Refers to both physical accessibility, such as roads and paths, but also psychological accessibility, such as feeling of privacy and barriers in the landscape
Arboretum	A display garden with different trees, mostly for educational purposes
Amphibians	Ectothermic, tetrapod vertebrates of the class Amphibia. Ex: Frogs
Biodiversity	Refers to species diversity and genetic diversity of terrestrial and aquatic organisms in an area
Biotope	Biological term for a type of environment which constitutes a habitat for a certain assemblage of species of plants and animals
Carbon dioxide sink	A natural or artificial reservoir that accumulates and stores some **carbon**-containing chemical compound for an indefinite period
Chemical status	Refers to the statues of water based on the levels of pollutants in surface water. Classification scale is good or satisfactory / not reaching good status
Cultural landscapes	Refers to landscapes transformed by human activity. For example, farmland, urban landscapes and industrial landscapes
Connectivity	In ecology, is the degree to which the landscape facilitates or interfere with the movement of species among resource patches, such as e.g. mating- or feeding grounds

Coniferous forest	A terrestrial biome found in temperate regions of the world with warm summers and cool winters and adequate rainfall to sustain a forest
Cultural heritage	The legacy of physical artifacts and intangible attributes of a group or society that are inherited from past generations, maintained
dB,dBA	A logarithmic unit used to express the ratio of two values of a physical quantity Ex: dBA, A-weighting, a sound level unit
Detailed development plan	Law-binding rules for where new buildings may be located and how they should appear
Deciduous forest	Forests where a majority of the trees lose their foliage at the end of the typical growing season are called deciduous forests. These forests are found in many areas worldwide and have distinctive ecosystems, understory growth, and soil dynamics
Diversity	variability within species, between species and between ecosystems
Dispersal	the movement of individuals (animals, plants, fungi, bacteria, etc.) from their birth site to their breeding site ('natal dispersal'), as well as the movement from one breeding site to another ('breeding dispersal')
Comprehensive plan	Covers the entire municipality's area. It shows how the municipality would like the city and land to be and appear in the future and which areas the municipality thinks should and should not be used for building
Core area	In ecology an area which qualities make it particularly valuable to plants and animals
Edge nibbling	Long term removing of small pieces of a specific area

Ecoduct	A bridge for increased connectivity for ground-bound animals
Effect	The physical change of the environment Ex: remove some trees to make a road What the effects result in; for example less nature → less health is the actual impact
Fault scarp	A small step or offset on the ground surface where one side of a fault has moved vertically with respect to the other. It is the topographic expression of faulting attributed to the displacement of the land surface by movement along faults
Fragmentation	The emergence of discontinuities (fragmentation) in an organism's preferred environment (habitat), causing population fragmentation and ecosystem decay
F-6	A school with classes from the preparatory year up to year six
F-9	A school with classes from the preparatory year up to year nine.
Förbifart Stockholm	A bypass with the purpose to improve the accessibility for car traffic in Stockholm
Green corridor	An area of habitat, connecting populations of species, that has been separated by human activities. The exchange of individuals between populations may decrease negative effects such as inbreeding and a reduction of genetic diversity which often occur within isolated populations.
Green compensation	Compensation for lost green areas. Ex: Through management measures, restoration of damaged environments, creating new habitat or by the long-term protection of natural areas that previously lacked protection etc.

Ecosystem Services (ESS)	*Provisioning*, such as the production of food and water; *regulating*, such as the control of climate and disease; supporting, such as nutrient cycles and crop pollination; and cultural, such as spiritual and recreational benefits
Geomorphology	Scientific study of the origin and evolution of topographic and bathymetric features created by physical, chemical or biological processes operating at or near the Earth's surface.
Habitat	Refers to the living environment where a plant or animal species live under specific conditions
Hard surface	Refers to the area that does not allow rainwater infiltrated
Hibernation	Is a state of inactivity of animals, where body temperature, heartbeat and metabolic rate drop
Impact	What the effects result in; for example, less nature → less health is the actual impact. Ex: Habitat fragmentation due to removed trees
Infrastructure	Refers to physical structures and functions in society. Includes the roads, sewerage, electricity supply and waste management
Makrophyte	An aquatic plant that grows in or near water
National Interest	Areas with values regarded as important on a national level e.g. natural and cultural environments that are of importance to preserve
Natura 2000	An area or network protected by the EU to promote certain natural environments
Newly arrived	Recently immigrated persons with residence permission where the municipality is

	responsible for finding housing options for them.
Noise	Refers to unwanted sound in air, ground and water. Noise pollution can affect human and animal health.
Orientability	The capacity of an area to be orientated by a person with visual or cognitive deficiencies
Recreation area	Refers to an area that is attractive for various recreational activities for the public. For example, the areas suitable for walking, jogging and playing or just enjoyment of surroundings
Recreational values	Values that involve the availability for walking, playing and other leisure activities
Red listed species	Species with an unknown future and that needs protection
Safety distance	Guidelines regarding the distance to residential areas from different elements, e.g. cultural objects and industrial facilities, that has been established by statutory authorities e.g. National Board of Housing, Building and Planning and The Environmental Protection Agency
Stormwater	Refers to the water on surfaces that can not be infiltrated. Origin of the water is from rain, melting and flushing water or emergent groundwater.
Socioduct	A broader bridge that is built to reduce social barriers between areas and create social connectivity
Soil condition	Soil structure, stratigraphy and quality

SS	Suspended Solid
Stockholms Green Wedges	A collection of 10 large nature areas in Stockholm county which extends from the suburbs outside Stockholm and inwards toward the city center. Providing green infrastructure close to developed areas
Usability	The degree to which an area an environment is accessible and orientable for persons with disabilities
Water condition	Refers to abiotic factors such as chemical and physical conditions, as well as the ecological status, in the aquatic environment within an area
Water recipient	The term for water bodies that receives waste products through the transportation of water
Wetland	A land area that is saturated with water, either permanently or seasonally, such that it takes on the characteristics of a distinct ecosystem
Wooded bog areas	A bog is an area of moist, soggy ground, usually with peat formed by the decay and carbonization of mosses and other vegetation in the bog

Abbreviations

Zn - Zinc

Cu - Copper

Cr - Chromium

Cd - Cadmium

Hg- Mercury

EIA - Environmental Impact Assessment

EIS - Environmental Impact Statement

EPA - Environmental and Protection Agency

ESS - Ecosystem Services

EQS - Environmental Quality Standards

EQO - (The Swedish) Environmental Quality Objectives

NO_2 - Nitrogen dioxide

N- Nitrogen

Ni- Nickel

NOx- Nitrogen Oxides

P- Phosphorus

PAHs - Polycyclic aromatic hydrocarbon

RUFS - Regional utvecklingsplan för Stockholm

The Planning and Building Act- Plan- och bygglag

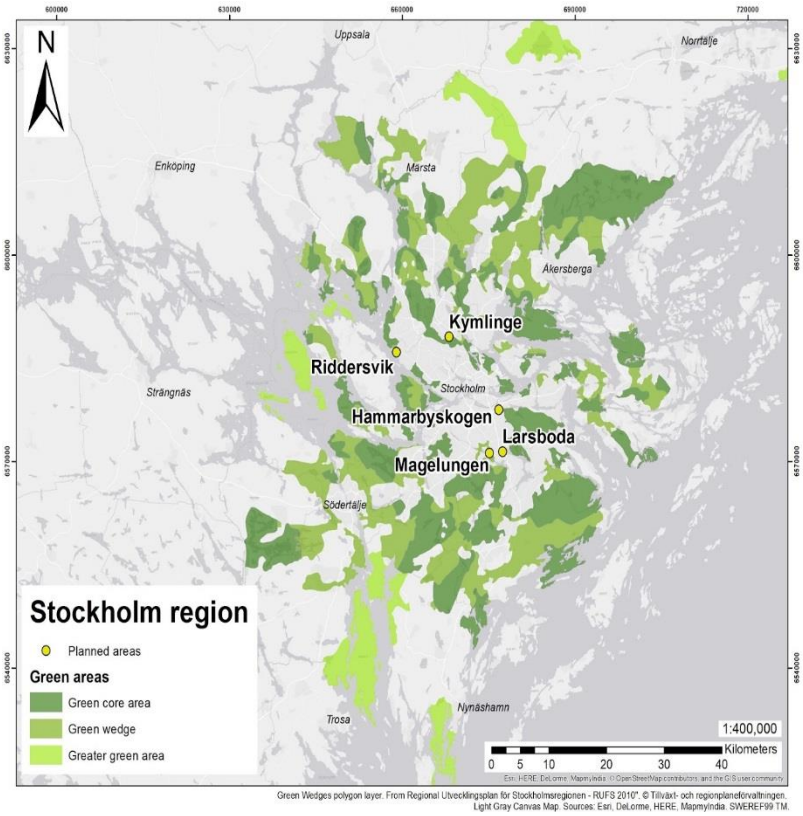
Species Protection Ordinance – Artskyddsförordningen

Contents

General introduction

Background and purpose

This report consists of Environmental Impact Assessments of five areas in the Stockholm region.



Map 1. Map marking the project areas and important green areas as pointed out in the Regional Development Goals (RUFS, 2010, 156).

The areas are currently unexploited and the planning processes are all in different stages. The common denominator is that they are all are located in green areas within a region with growing population and housing shortage (Länsstyrelsen, 2016).

To give the reader the background and to explain why we make Environmental Assessments, the following section explains the planning and legal framework and environmental objectives common to the individual assessments in this common report.

The Swedish planning process

The legal framework for the Swedish planning process is defined primarily in the Plan and Building Act (2010:900) and in the Environmental Code (1998:808). It is the Swedish municipalities that have a monopoly on planning in Sweden (Nyström & Tonnell, 2012). But the framework for the planning process is set by the government through the Plan and Building Act. The County Administrative Boards (*Länsstyrelserna*) monitor that the planning in the municipalities follow the national interests and goals, they also are required to act as an advisor for both the constructor and the municipality.

The municipalities can act both as an authority and a property owner (Boverket, 2016a). The municipality writes and approves the Comprehensive Plan (*översiktsplan*), Detailed Development Plans (*detaljplaner*) and Area Regulations (*områdesbestämmelser*) (Nyström & Tonell, 2012). In every municipality there is a local Building Authority (*byggnadsnämnd*) that is constituted of trustees and public servants that approves and monitor the plans from a legal point of view (Boverket, 2016a, web page).

The developer (*byggherre*) is the person or organisation that has been commissioned to construct the project (or parts of it). They have the overall responsibility to make sure that the project fulfills current laws and that monitoring is done in a proper way (Boverket, 2016a, web page; Byggherrarna, 2016, web page).

The Comprehensive Plan is there to regulate the development of the municipality as a whole. It must display the intended use of water and land and the end result present the "usage/conservation of land and water, localization and dimensions of buildings, infrastructure and service" (Nyström, 1999, 119). The Comprehensive Plan should be accepted by the City Council (kommunfullmäktige), every four years and the Council should decide whether the plan shall be extended or is in need of renewal (Boverket, 2016b, web page). It is not legally binding, and can therefore not be appealed against. Though whenever the municipality should choose to develop areas in such a way that they do not conform to the Comprehensive Plan, they must present their reasons for doing so through a programme (Nyström och Tonell, 2012).

The Detail Development Plan is more of a small scale, detailed document that is legally binding. This process is initiated by the municipality or developer. The initial phases of planning are not regulated in law, therefore an agreement is often struck in the beginning between the involved parties to divide the costs of the planning process (Iverlund & Ultenius, 2008). At the start of the process a promemoria is written by the Town Planning Office, which describes the project. Should the Detailed Development Plan differ from the Comprehensive Plan, a programme might also be developed. Before the programme stage there will often be a pre-study of the area, with the purpose to find out whether the project should be done at all (ob. cit).

At the next stage investigations are carried out; possible impacts are examined from an economic, environmental and social perspective. The Environmental Assessment (*miljöbedömning*) also helps to inform the decision of whether an Environmental Impact Assessment (EIA) will be necessary. During the development of the Detailed Development Plans the municipality is required to consult the County Administrative Board (*Länsstyrelsen*), the Land Surveying Authorities (*Lantmäteriet*) and other municipalities that may be affected by the proposed plan (Iverlund & Ultenius, 2008). They must also arrange so the people that might get affected by the plan, as well as relevant authorities and organizations, can have their opinions stated (Nyström & Tonell, 2012).

Referral and consultation documents are then developed and the proposed plan will be tried against the Plan and Buildings Act. Once approved the proposed plan must be presented in a public space for at least 3 weeks (Nyström & Tonell, 2012). The presented plan must at least contain; a map of the plan with conditions, a description of the plan, description of implementation, an account of the consultation process, a base map, list of real estate, illustrations and if applicable the program and the EIA (Iverlund & Ultenius, 2008). During this time different stakeholders can state their issues with the plan. At the end of the time of presentation, the municipality must compile the opinions on the plan in a verdict (ob. cit.). Should the plan substantially change in light of the stakeholders' critique then the plan must be presented to the public in the same fashion once more.

Once the presentation period is over either the County Administrative Board approves the plan or, if the plan is considered to be of minor importance, they delegate the decision to the Municipal Board (*kommunstyrelsen*). The

decision is followed by a period (*besvärsskede*) lasting three weeks during which the individuals that did not have their complaints catered to during the time of presentation may appeal against the plan with the County Administrative Board as first instance, and the government as second instance (Iverlund & Ultenius, 2008). Should the plan not be appealed against or the appeal be denied, then the plan will enter into legal force at the end of the three-week period.

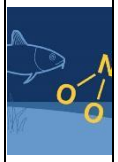
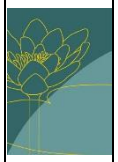
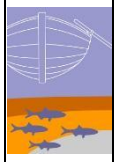
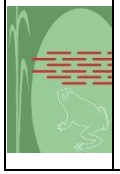
Environmental and Planning Objectives

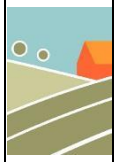
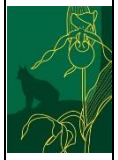
Environmental Objectives

The Swedish Environmental Objectives (EOs) are aiming to safeguard the environment. They are consisting of three parts; the Generational Goal, 16 Environmental Quality Objectives (EQOs) and 24 Milestone Targets. The Generation Goal provides guidance to solve current environmental problems within one generation. The EQOs are a set of environmental qualities that are further specified and are supposed to be reached by 2020 (Table 1). The Milestone Targets represent necessary steps towards the achievement of the Generational Goal and the EQOs (Naturvårdsverket, 2016a; 2016b).

Table 1: The Swedish Environmental Quality Objectives and their official description (Naturvårdsverket, 016a), an assessment of the prospects of achieving them by 2020 as well as current trends in the environment (Naturvårdsverket, 2016b). The table also contains the official illustrations of the EQOs by Tobias Flygar (Miljömål.se, 2012).

	Environmental Quality Objectives	**Description**	**Will be reached by 2020?**	**Trend**
	**Reduced Climate Impact**	"In accordance with the UN Framework Convention on Climate Change, concentrations of greenhouse gases in the atmosphere must be stabilised at a level that will prevent dangerous anthropogenic interference with the climate system. This goal must be achieved in such a way and at such a pace that biological diversity is preserved, food production is assured and other goals of sustainable development are not jeopardised. Sweden, together with other countries, must assume responsibility for achieving this global objective."	No*	Negative
	**Clean Air**	"The air must be clean enough not to represent a risk to human health or to animals, plants or cultural assets."	No	Positive
	**Natural Acidification Only**	“The acidifying effects of deposition and land use must not exceed the limits that can be tolerated by soil and water. In addition, deposition of acidifying substances must not increase the rate of corrosion of technical materials located in the ground, water main systems, archaeological objects and rock carvings.”	No	Positive
	**A Non-Toxic Environment**	“The occurrence of man-made or extracted substances in the environment must not represent a threat to human health or biological diversity. Concentrations of non-naturally occurring substances will be close to zero and their impacts on human health and on ecosystems will be negligible. Concentrations of naturally occurring substances will be close to background levels.”	No	Neutral
	**A Protective Ozone Layer**	“The ozone layer must be replenished so as to provide long-term protection against harmful UV radiation.”	Yes	Positive

	**A Safe Radiation Environment**	"Human health and biological diversity must be protected against the harmful effects of radiation."	Partly	Neutral
	**Zero Eutrophication**	"Nutrient levels in soil and water must not be such that they adversely affect human health, the conditions for biological diversity or the possibility of varied use of land and water."	No	Neutral
	**Flourishing Lakes and Streams**	"Lakes and watercourses must be ecologically sustainable and their variety of habitats must be preserved. Natural productive capacity, biological diversity, cultural heritage assets and the ecological and water-conserving function of the landscape must be preserved, at the same time as recreational assets are safeguarded."	No	Neutral
	**Good-Quality Groundwater**	"Groundwater must provide a safe and sustainable supply of drinking water and contribute to viable habitats for flora and fauna in lakes and watercourses."	No	Neutral
	**A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos**	"The North Sea and the Baltic Sea must have a sustainable productive capacity, and biological diversity must be preserved. Coasts and archipelagos must be characterised by a high degree of biological diversity and a wealth of recreational, natural and cultural assets. Industry, recreation and other utilisation of the seas, coasts and archipelagos must be compatible with the promotion of sustainable development. Particularly valuable areas must be protected against encroachment and other disturbance."	No	Neutral
	**Thriving Wetlands**	"The ecological and the ecological and water-conserving function of wetlands in the landscape must be maintained and valuable wetlands preserved for the future."	No	Negative

	**Sustainable Forests**	"The value of forests and forest land for biological production must be protected, at the same time as biological diversity and cultural heritage and recreational assets are safeguarded."	No	Neutral
	**A Varied Agricultural Landscape**	"The value of the farmed landscape and agricultural land for biological production and food production must be protected, at the same time as biological diversity and cultural heritage assets are preserved and strengthened."	No	Negative
	**A Magnificent Mountain Landscape**	"The pristine character of the mountain environment must be largely preserved, in terms of biological diversity, recreational value, and natural and cultural assets. Activities in mountain areas must respect these values and assets, with a view to promoting sustainable development. Particularly valuable areas must be protected from encroachment and other disturbance."	No	Negative
	**A Good Built Environment**	"Cities, towns and other built-up areas must provide a good, healthy living environment and contribute to a good regional and global environment. Natural and cultural assets must be protected and developed. Buildings and amenities must be located and designed in accordance with sound environmental principles and in such a way as to promote sustainable management of land, water and other resources."	No	Positive
	**A Rich Diversity of Plant and Animal Life**	"Biological diversity must be preserved and used sustainably for the benefit of present and future generations. Species habitats and ecosystems and their functions and processes must be safeguarded. Species must be able to survive in long-term viable populations with sufficient genetic variation. Finally, people must have access to a good natural and cultural environment rich in biological diversity, as a basis for health, quality of life and well-being."	No	Negative

**the deadline for the Environmental Quality Objective of 'Reduced Climate Impact' is 2050 instead of 2020*

Regional Objectives

The Regional Development Plan (commonly known as *RUFS*) from 2010 was developed by the Regional Development Office (Tillväxt- och Regionplaneförvaltningen, Stockholms Läns Landsting) and is the strategic development plan for all 26 municipalities in Stockholm. The Office is working on the next development plan, RUFS 2050 (Tillväxt- och Regionplaneförvaltningen, 2016). However, this plan is still in its consultation phase and might change considerably before final approval. Because of this, the focus is still on the current version from 2010.

It points out a number of important development goals for the region. By using 6 strategies with subsequent planning objectives and then followed by specific goals, RUFS shows the ideal direction of development. Two of those strategies are of specific importance for

the development proposals scrutinized in this environmental impact assessment are discussed shortly below.

One of the strategies is to "*secure existing values for future needs".* It concerns for instance the natural-, cultural- and recreational environments and states that such environments should be both *protected* and to be further *developed*. Its second objective is about climate, energy and transports. This part states that the region should decrease its effect on the environment and that the transportation systems need to be efficient. The negative effects from transportation systems should be limited.

Another strategy is to "*develop a multi-centric and dense region".* The planning goal is that the city becomes *multi-centric* and has a *compact city structure.* Today Stockholm is a mono-centric region with a very mono-centric city center, which puts a lot of strain on our transport infrastructure. With a growing population, the demands on all kinds of traffic infrastructure will continue to increase. Instead of leading everyone into the inner city over the Central Station, the plan point towards that new housing areas should be planned close to important *core access points* where they could be combined with public services. Such regional cores should be further developed. This would also make transverse travelling easier (i.e. bus or tram from east to west). One of the goals is also that people should have a *good access to work places, green spaces, water and technical infrastructure.*

Additional points are that the *density of the built environment should increase* and that *it becomes more varied*. An attractive city environment with public spaces, parks and green environment should be built, that also create possibilities for *dynamic evening economies* in the city's core areas.

The same strategy also includes goals about *green wedges and beaches*. Following this the people in the region should have *good access to nature in close proximity to residential areas*. This means that those *assets should be secured, developed and the access to the green wedges should increase.*

It becomes clear that the problem with these goals is that that they are in conflict with each other. On the one hand, existing values should be protected for future needs. On the other hand, they are to be changed/developed for the needs of a growing population. As the RUFS-goals are not legally binding, it is up to the municipalities to make their own judgments of the importance between them.

Comprehensive Plan

In the following section, the Planning Objectives from the Stockholm Comprehensive Plan are presented in more detail.

This plan is relevant for four out of five projects (Hammarbyskogen, Larsboda, Magelungen and Riddersvik) but not for the Kymlinge projec. This project it is located within the municipality of Sundbyberg. However, as the project is not mentioned in their Comprehensive Plan, this plan is not presented below.

The Stockholm City Plan (2010) is the Comprehensive Plan ("översiktsplan") showing water and land use as well as development of the built environment for the near future. An updated version of the plan is now out on consultation between 2016-11-10 and 2017-01-10. Since a final version has not been agreed on politically, we have chosen to use the 2010 version.

The plan points out four strategies that will help the city grow in a more sustainable way: *strengthen central Stockholm, focus on strategic nodes, connect city areas* and *create a vibrant urban environment.* The first focuses on how with the rapid city-growth, the inner city is expanding outside the historic city borders. Growth should be focused along the outer parts of the subway lines, which provides citizens with good public transportation access and enables more people to go by bike or walk to their destinations. Some of these are well connected to the city core but not between each other and a stated goal is to improve those connections.

The document mentions some risks when densifying: air- and noise pollution, increased pressure on logistics that can cause risks and that development might destroy green areas in a time when the need for recreational green space increases.

The second strategy focus on specific core areas and mentions Kista, Vällingby, Spånga, Brommaplan, Skärholmen, Farsta, Fruängen, Älvsjö and Högdalen. Four of the five environmental impact assessment (EIA) projects produced in this document are located in close proximity to those cores. The fifth project connects with two expanding inner city areas, Hammarby Sjöstad and Gullmarsplan.

The third and fourth strategy goals of *connecting city areas* and *creating a vibrant urban environment* put more focus on the quality of city areas. Workplaces and offices should be found around the city, which could decrease the pressure on both road- and public transportation infrastructure, and citizens could walk more often or use their bicycles. Access to schools, services, parks or green spaces should be improved. Evening activities like visiting restaurants, cafes or entertainment should be found locally. Environments that are used continually throughout the day and into the evening expand the citizens' sense of security and greatly increase the attractiveness of areas.

Legislation

EU Directive

In order to prevent further environmental deterioration, the EU Directive 85/337/EEC was implemented in 1985. According to the Directive, an EIA is required for two classes of projects, one mandatory (Annex I) and one discretionary (Annex II):

"Projects of the classes listed in Annex I shall be made subject to an assessment... for projects listed in Annex II, the Member States shall determine through: (a) a case-by-case examination; or (b) thresholds or criteria set by the Member State whether the project shall be made subject to an assessment... When [doing so], the relevant selection criteria set out in Annex III shall be taken into account" (Article 4).

In other words, all projects listed in Annex I are considered as having significant effects on the environment and require an EIA. For projects listed in Annex II, the authorities are required to decide whether an EIA is needed with the "screening procedure", which determines the effects of projects on the basis of thresholds/criteria or a case-by-case examination. Moreover, the authorities should also take into account the projects listed in Annex III.

The EIA Directive of 1985 has been amended three times, in 1997, 2003 and 2009. The implementation and development of the Directive greatly influenced the EIA systems in EU Member States. The EIA is viewed as a significant technique for incorporating environmental considerations into the planning process (Glasson *et al.*, 2013).

The EIA Directive is transposed into Swedish legislation mainly by the Environmental Code (SFS 2000:61) and the Ordinance on Environmental Impact Assessments (SFS 1998:905). The Environmental Code contains several provisions regarding the preparation of the EIA. It also contains chapter 6, with General Regulation on Environmental Impact Statements (EIS) and Environmental Impact Assessments (EIA). Over the past decades, EIA has become an important tool in project planning in Sweden and its applications are likely to expand further (Edvardsson, 2004).

Swedish Environmental Legislation

Swedish Environmental Code

National interests - Riksintressen

National interests are geographical areas determined to contain unique or otherwise important values or qualities of national concern. The term national interests is used in the Swedish Environmental Code regarding two different types of aas. One type stems from chapter 4 which states that *the government may declare an area to be of national interest*. The other type is described in chapter 3 of the Environmental Code and *it is the responsibility of the relevant authorities to assert claim and oversight of the areas.*

How national interests relate to other interests is supposed to be presented in the municipalities comprehensive plans in a way that clarifies how tradeoffs and judgements are to be considered (Boverket, 2016a).

Basic provisions concerning the management of land and water areas

Authorities, organizations, companies and individuals are obliged to follow the basic provisions concerning the management of land and water areas conditioned by the Swedish Environmental Code (SFS 1998:808) in chapter 3. Land and water areas shall be used for the purposes for which they are best suited in view of their situation (chapter 3 section 1) while land and water areas that are, from an ecological point of view, particularly vulnerable shall be protected against damaging measures to the extent possible (chapter 3 section 3). Protection against damaging measures, to the extent possible, shall also apply land and water areas as well for the general physical environment that are important in regards to public interest due to their natural or cultural value for outdoor recreation. The need for green spaces in and near urban areas shall be given special consideration according to chapter 3 section 6.

Protection of areas

Nature reserves

According to chapter 7 section 8 (SFS 1988:808), decisions regarding the establishment or alteration of nature reserves must not conflict with Detailed Development Plan or Area

Regulations in accordance to the Planning and Building Act (SFS 2010:900). Minor modifications may be made if this does not conflict with the purposes of the plans or regulations.

Shore protection areas

Shore protection applies by the sea, lakes and watercourses with the purpose of assuring public access to outdoor recreation facilities and to maintain good living conditions for plant and animal species on land and water, according to chapter 7 section 13 (SFS 1998:808). Land and water areas shall be protected up to 100 m from the shoreline. However, the government may extend this area to not more than 300 m from the shoreline if necessary, according to chapter 7 section 14 (SFS 1998:808). Within a shore protection area, it is, according to chapter 7 section 15 (SFS 1988:808), prohibited to:

1. erect new buildings;
2. alter buildings in order to serve a purpose that is significantly different from previous use;
3. digging or other preparations for the purpose of construction work referred to in point 1 and 2;
4. measures which significantly affects the living conditions for animal and plant species.

According to chapter 17 section 18 (SFS 1998:808), the County Administrative Board may grant exemptions from the shore protection in an area if it is:

1. obvious that the area lacks significance in the provision of the intended shore protection,

2. the shore protection applies to a small lake or watercourse and the areas significance for the shore protection is little, or

3. if the area, according to the Planning and Building Act (SFS 2010:900), is part of a Detailed Development Plan and is needed for building of a defense facility, public road or rail road.

The same section also states that conditions regarding the municipality's possibility to withdraw the shore protection through provisions in a Detailed Development Plan are found in chapter 4 section 17 in the Planning and Building Act (SFS 2010:900).

According to Chapter 7 section 18 b, the municipality may allow exemption from the shore protection if there is special circumstances that motivates it. The exemption is reviewed by the County Administrative board and can be repealed if the exemption is not satisfactory as to the criteria listed in the Environmental Code.

Environmental Impact Statements

The purpose of an Environmental Impact Assessment (EIS) is to identify and describe the direct and ind irect impact of a planned activity or measure on several factors, including: "*people, animals, plants, land, water, air, the climate, the landscape and the cultural environment, on the management of land, water and the physical environment in general, and on other management of materials, raw materials and energy*", according to chapter 6 section 3 (SFS 1998:808). Enabling the overall assessment of the impact on human health and the environment is another purpose of an environmental impact assessment.

Authorities or municipalities that establish or alters a plan or program, shall conduct an environmental assessment if the implementation is presumed to have significant impact, according to chapter 6 section 11 (SFS 1998:808). Within the framework of an environmental assessment, the authority or municipality shall establish an environmental impact

assessment to identify, describe and assess the significant impacts the plan or program is assumed to imply, according to chapter 6 section 12 (SFS 1998:808), which further states that the environmental impact assessment shall include:

1. A summary of the content of the plan or program and main purpose
2. A description of the environmental conditions and the probable development of the environment if the plan or program is not implemented
3. A description of the environmental conditions in the areas that are likely to be affected
4. A description of present environmental problems in areas of particular importance for the environment
5. A description of how relevant environmental objectives have been considered in the plan or program
6. A description of the expected significant impact on biodiversity, population, human health, ground, water, air climate, natural resources, landscape, built-up areas, cultural heritage and the connection between these aspects
7. A description of planned measures to prevent or mitigate negative effects on the environment
8. A summarizing statement of how assessments have been made, reasons behind the chosen alternatives and problems when compiling the document
9. A description of how measures being planned for following up and monitoring of the environmental impacts
10. A non-technical summary of points 1-9.

Planning and Building Act

The Planning and Building Act (SFS 2010:900) regulates provisions concerning the planning of water and land areas as well as construction. The overarching purpose is, according to chapter 1 section 1, to promote societal progress, with regard to the freedom of the individual, a clean and sustainable habitat for people in today's society and future generations. It states, in section 2, same chapter, that planning the use of land and water areas is a municipal responsibility.

The Planning and Building Act further regulates provisions on Comprehensive Plans (chapter 3), Detailed Development Plan (chapter 4-6) and Building Permits (chapter 9). According to chapter 3, every municipality must have a current Comprehensive Plan (section 1) that provides guidance for decisions on how the land and water areas are to be used and how the built environment is to be used, developed and protected (section 2). Chapter 4 section 2 regards the requirements for regulation by means of a Detailed Development Plan and includes that a municipality must examine the suitability of a land or water area for built environment and construction works for "*new construction works (…) if the construction works require a building permit (…) and the use of the construction works will have a significant impact on its surroundings (…)".*

Heritage Conservation Act

The Heritage Conservation Act (SFS 2015:852) refers to the protection and preservation of cultural environments in Sweden. The act contains regulations for protection of certain cultural valuable objects and monuments. The act's main purpose is to avoid damage on the cultural environment during construction work, but also to consider objects and monuments during the planning process. The County Administrative Board has the main responsibility for the work with cultural heritage in each county, while the Swedish National Heritage Board ("riksantikvarieämbetet") has the supervision for all of Sweden.

Hammarbyskogen

1. Icke teknisk sammanfattning

I Stockholm pågår en kraftig befolkningstillväxt och därför har kravet på bostadsbyggande ökat. Som en del av förtätningen av Stockholm planeras mellan 2 300 och 2 700 bostäder i Hammarbyhöjden och Björkhagen. Denna miljökonsekvensbeskrivning fokuserar på effekterna av den föreslagna bebyggelsen i Hammarbyskogen samt i den intilliggande skogsbranten som i rapporten kallas Sjöstadshöjden.

I *Program för Hammarbyhöjden och Björkhagen* (Stadsbyggnadskontoret, 2016) finns planerna för ett nytt bostadsområde i Hammarbyskogen. Utvecklingen av projekten i området skulle resultera i 950-1150 bostäder, två-fyra förskolor samt en grundskola. Utöver det föreslås att Hammarbyhöjdens IP ersätts med en ny idrottsplats med ett underliggande garage. Syftet med utvecklingen av Sjöstadshöjden är att koppla samman Hammarbyhöjden med Hammarby Sjöstad som idag separeras av både en skogsbrant och en kraftigt trafikerad väg i ett industriområde längs med Hammarbyvägen/Hammarby Fabriksväg. Enligt programmet föreslås en bilväg genom Hammarbyskogen ner till Hammarby Sjöstad. Dock är utformningen av denna väg under fortsatt diskussion och eventuellt kommer partier av vägen endast användas som gång- och cykelväg.

Stockholms Stad gjorde bedömningen att programmet inte medförde en betydande negativ miljöpåverkan eller gick emot gällande lagar och regler. Därför gjordes ingen miljökonsekvensbeskrivning utan endast utredningar inom ett antal områden.

Hammarbyskogen består till största del av hällmarkstallskog. I skogen finns partier av äldre tallskog, värdefulla bestånd av äldre ek samt områden med död ved som är viktiga för insektslivet. Våtmarksområdet i skogen är av stor vikt för groddjur, insekter och fåglar. Den varierade vegetationen indikerar att Hammarbyskogen har potential att hysa en stor diversitet av arter. Exempelvis mindre hackspett, duvhök och snok har påträffats i området.

Hammarbyskogen och Sjöstadshöjden utgör idag en grön korridor som är viktig för spridningssambandet mellan Nackareservatet och Årstaskogen som i övrigt är isolerat från andra skogsområden. Korridoren gör det möjligt för djur och växtarter att röra sig mellan Nackareservatet och Årstaskogen. Sambandet anses känsligt vid smala partier såsom Sjöstadshöjden och området kring Gullmarsplan.

Hammarbyskogen är också ett välutnyttjat rekreations- och grönområde. Skogen är mycket lättillgänglig och besöks dagligen av bland annat motionärer, hundägare och förskolegrupper. Skogen är isolerad från bilväg och trafik vilket gör skogen till en lugn och säker miljö och lämplig för barn att röra sig fritt i. Rekreationsvärdet benämns därför som högt.

De potentiella konsekvenser som följer av en exploatering av Hammarbyskogen och Sjöstadshöjden återfinns i kapitel 8. Konsekvenserna redovisas i en tabell där bedömningen av konsekvensernas storlek gjorts utifrån hur olika nationella, regionala och lokala mål uppnås. Fyra områden; vegetation, fauna, rekreation och lokal luftkvalitet, är särskilt värdefulla ur ett miljöperspektiv. Dessa riskerar stora negativa konsekvenser om programmet genomförs. För områdena; kulturmiljövärden,

geologi, hydrologi och bullernivåer är riskerna för negativa konsekvenser mindre.

Positiva effekter av bebyggelsen finns däremot för sociala- och ekonomiska samhällsområden.

Om en stor del av skogen ersätts med ett bostadsområde befaras de negativa följderna för natur- och rekreationsvärden tillsammans med luftkvalitet och lokalt klimat vara mycket stora. Exempelvis riskeras en förlust av värdefulla våtmarker, förlorad artdiversitet samt ett ökat slitage på kvarvarande skogsområde. Dessutom finns en möjlighet att våtmarkerna innehåller arter av groddjur som har ett starkt lagligt skydd. Dessa risker bör vara tillräckligt för att motivera Stockholm stad till att genomföra en fullständig miljökonsekvensbeskrivning. Ett alternativt förslag till bebyggelse har arbetats fram och presenteras kapitel 6. Förslaget medför liknande negativa effekter trots att antalet lägenheter reducerats och bebyggelsen lokaliseras på ett annorlunda sätt. Slutsatsen är därför att de negativa effekterna av bebyggelse i området blir allt för stora samt svåra att undvika. Baserat på den efterforskning som sammanställt, de utredningar som saknas och riskerna som kan följa av bebyggelse anser vi att exploatering av Hammarbyskogen och Sjöstadshöjden bör undvikas.

2. Non-technical summary

The Stockholm region is experiencing a fast population growth and the demands for building more residential housing has grown as well. As a part of the densification of Stockholm, between 2 300 and 2 700 housing units are planned in the areas of Hammarbyhöjden and Björkhagen. This Environmental Impact Assessment (EIA) is focusing on the effects of the proposed building plans in Hammarbyskogen together with the nearby forested area called Sjöstadshöjden.

In the *City's Program for Hammarbyhöjden och Björkhagen* (Stadsbyggnadskontoret, 2016) the plans for a new residential area in Hammarbyskogen are presented. The development would result in 950-1150 residential units, two-four preschools and a new elementary school. The current sports field Hammarbyhöjdens IP would be replaced by a new facility with an underground garage. Another purpose of the development in Sjöstadshöjden is to connect Hammarbyhöjden with Hammarby Sjöstad, which today are separated in two ways; both by a steep, forested area and a highly trafficked road connecting to the industrial area along Hammarbyvägen/ Hammarby Fabriksväg. In the Program a new road between the development in Hammarbyskogen and Hammarby Sjöstad is proposed. However, the road has been heavily contested and suggestions have been to make parts of it only accessible for pedestrians and bicyclists.

The City of Stockholm have made the judgment that the development of the Program would not cause any significant environmental impacts or that it would go against current laws and regulations. Because of this, no environmental impact assessment was made. Investigations were only conducted for parts of the area.

Hammarbyskogen is dominated by coniferous forest, which mainly consists of old populations of pine. In the forest there are valuable populations of old pine and oak trees as well as areas with dead wood that are important for insect life. The wetland area is of great importance for amphibians, insects and birds. This varied vegetation indicates that Hammarbyskogen shows great potential to host a wide variety of species.

Today Hammarbyhöjden and Björkhagen constitutes a green corridor important for migrating wildlife species between Nackareservatet and Årstaskogen. The area is otherwise isolated from other forest areas. This connection is found to be sensitive along narrow parts around Sjöstadshöjden and the area around Gullmarsplan.

Hammarbyskogen is also a highly used recreational- and green area. The forest is easily accessible and is visited daily by people exercising, dog owners and preschool groups. The forest is isolated from car traffic, which makes the forest a calm and secure environment suitable for children to move and play freely. Consequently, the recreational values are considered to be high.

Potential impacts from exploitation are presented in chapter 8. The consequences are listed in a matrix and assessed by how different national-, regional- and local targets would be met. From an environmental point of view four areas; vegetation, fauna, recreation and local air quality, are recognized to be especially valuable. If the Program is carried out, those risk large negative consequences. The following areas; cultural heritage, geology, hydrology and noise, risk only smaller negative consequences. Positive effects from development could on the other hand be expected within social-, and economic areas.

If a large part of the forest is replaced by a residential area, the negative effects for natural- and recreational values, together with air quality and local climate, could turn out to be very large. For example, there is a risk of losing valuable wetlands, decreasing biodiversity and that the wear and tear on the remaining forest would increase. There is also a possibility that the wetlands contain amphibian species that are legally protected. Such risks should be sufficient to motivate the City to conduct a complete EIA.

An alternative suggestion to the design of the proposed residential area has been made and is presented in chapter 6. It was found that even when the number of residential units was reduced and that the residential area was designed differently, the alternative would result in similar negative effects. Our conclusion is that negative effects from development would be large and that it would be hard to avoid with any modified development in the area. Based on the research conducted, the investigations that are still missing as well as the risks that could result from development, we conclude that the exploitation of Hammarbyskogen and Sjöstadshöjden should be avoided.

3. Introduction

3.1. Background and purpose

Stockholm is experiencing a significant population increase due to an attractive dynamic labor market and high quality education opportunities. Consequently, demand for housing is large and therefore residential housing areas are required to be extended. To meet the needs of a growing city, and to move towards the goal of 140 000 residential housing units in Stockholm by 2030, the area south of Stockholm's city center, is represented by a growing housing network between Hammarbyhöjden and Björkhagen (Stadsbyggnadskontoret, 2016). Stockholm City is the owner of this land and has the responsibility to give the permission for planning and building projects in this area. Since these districts are located close to Hammarbyskogen, urban developer are planning to extent the urban areas into the forest (Stadsbyggnadskontoret, 2016).

As included in the Program - Hammarbyhöjden och Björkhagen (Stadsbyggnadskontoret, 2016), 2 300 to 2 700 new apartments are planned to carried out and to identify sites for developing and completing of new buildings, preschools, an elementary

school, businesses, parks, sports, walking and cycling routes. The aim is also to create a connection between Hammarby Sjöstad and Hammarbyhöjden, increase the area's safety and to create services and recreation areas close to the already existing housing. Also, to densify the city to make it more functional by making it easier to find target locations in the area, such as schools, the metro station and commercial services (Atkins, 2014). In the northern edge of the program starts the next planned program, called Sjöstadshöjden. Sjöstadshöjden is located between Hammarby Sjöstad and Hammarbyhöjden. The City's Department for Exploitation ("Exploateringskontoret") has conducted a pre-study of Sjöstadshöjden, and 2016-03-10 they approved the start of a more detailed investigation. One prerequisite for developing the area is to cover the current road Hammarbyvägen, which now pose a barrier between the two neighborhoods (Exploateringskontoret, 2016).

In the Comprehensive Plan for Stockholm (2010, 60-61) Hammarby Sjöstad is pointed out to become more closely tied together with the area around Gullmarsplan and Globen/Slakthusområdet. In order to do that Sjöstadshöjden is to be developed into the more urban environment in Hammarbyhöjden and then creates the link to Gullmarsplan as well. Citizens in the residential areas should have easy access to workplaces and offices around Gullmarsplan and the road network should improve mobility between the different areas.

According to Stockholm City Planning Office no EIA will be conducted for the new detailed development plan for the program Hammarbyhöjden and Björkhagen since Stockholm City expect no significant environmental impacts to result from the program.

3.2. Boundaries

3.2.1. Environmental impacts

The purpose of an Environmental Impact Assessment (EIA) is to establish and describe the "direct and indirect impact of a planned activity or measure on people, animals, plants, land, water, air, the climate, the landscape and the cultural environment, on the management of land, water and the physical environment in general, and on other management of materials, raw materials and energy" (Swedish Environmental Code, 1998:808, English version chapter 6, section 3). We have tried to cover these impacts in the following chapters in this Environment Impact Statement (EIS): vegetation, fauna, cultural heritage, green areas and recreation, social aspects, traffic, hydrology, geology, noise, air and climate.

3.2.2. Physical

The geographic boundaries of the proposed plan include the neighborhoods of Hammarbyhöjden, Björkhagen and parts of Kärrtorp. However, our report focuses mainly on Hammarbyhöjden and Hammarbyskogen. The geographical boundary of this project includes the northern part of Hammarbyhöjden, the northwestern part of Björkhagen and a small part of the bordering Södra Hammarbyhamnen (figure 1). The forest borders to Nackareservatet in the east and Årstaskogen in the west.

This assessment also includes the nearby project called Sjöstadshöjden which is still under investigation. This area has been included since its development will have a large impact on the forest area to the north of as well as the on the species dispersal between Nackareservatet and Årstaskogen.

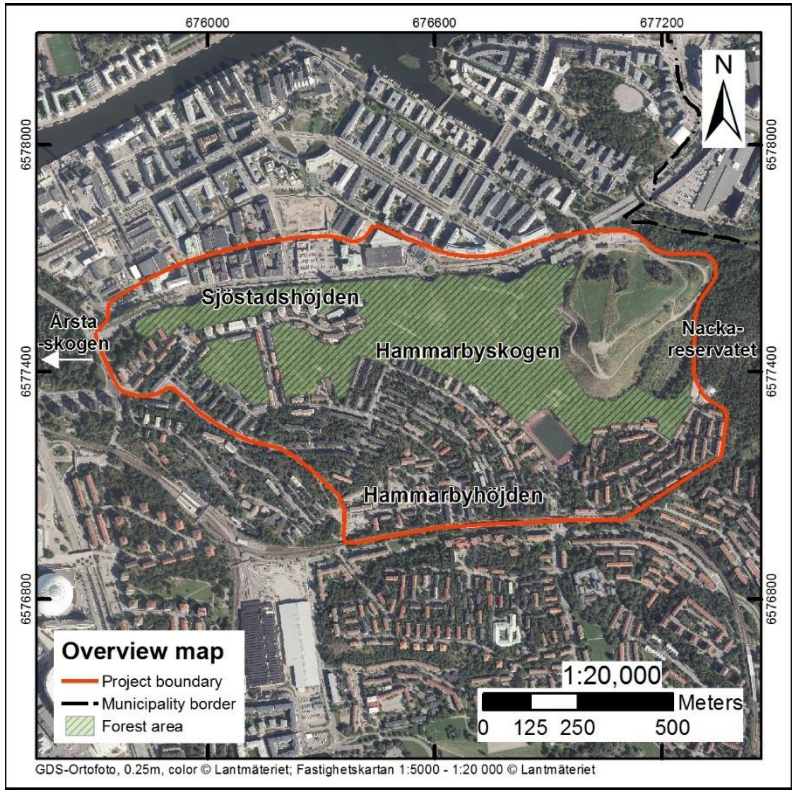


FIGURE 1. MAP SHOWING THE PHYSICAL BOUNDARY FOR OUR PROJECT AREA (IN RED). THE BOUNDARY OF THE PROJECT INCLUDES THE NORTHERN PART OF HAMMARBYHÖJDEN, THE NORTHWESTERN PART OF BJÖRKHAGEN AND A SMALL PART BORDERING TOWARDS SÖDRA HAMMARBYHAMNEN. THE FOREST BORDERS TO NACKARESERVATET IN THE EAST AND ÅRSTASKOGEN IN THE WEST.

2.2.3. Temporal

This report focuses on all values in Hammarbyskogen in its current state, the impacts on environmental and social impacts during the construction phase, and the potential consequences of those impacts after the project's completion. If no other specific time span is stated, we have used a decade to avoid too much uncertainty for such predictions.

4. Methods

The content of this report is mostly based on already existing information in the form of data from the city planning office, such as the program description, reports and investigations.

4.1. Field trips

The group made several field trips to the project area and its surroundings. One initial field trip was made with the whole class and teachers. Over the project's first two weeks the team members made additional field trips and investigations in smaller groups. These excursions were a good method to get a real-life impression of the area and to imagine how the proposed plan's effects could turn out. Also, discussions about potential alternative locations were made on site, which were very useful.

4.2. Interviews

To gather information during this project, several interviews have been done with nature experts, the developer and interest groups. Interviews have been conducted with the consultancy company *Ekologigruppen*, a representative for the Stockholm chapter of the *Swedish Society for Nature Conservation* (Naturskyddsföreningen), Stockholm municipality (the city planning office) and the interest group *Rädda Hammarbyskogen*. Interviews are summarized in 11.5 Personal communication. Since the planning process has come relatively far, local stakeholders living in the area have submitted their opinions on the project in two rounds of public participation meetings organized by the City. We have used the summary documents from those meetings for our conclusions.

Interviews were mostly done in groups of two to three persons and with interview questions that had been prepared by the whole project team. Interview questions are found in appendix A. All interviews but one was made person-to-person, the final one was done over the phone. All of them were recorded and then summarized in text.

Three additional organizations were contacted by mail: YIMBY, jagvillhabostad.nu and the Green Party. None of them decided to comment.

4.3.Scoping list

To determine which effects will result from the development and to start a discussion about the significance of them, we used a Scoping Checklist developed by the Commission of the European Union (EU). This was developed as a guidance for EIAs in 2001 (European Commission - DG Environment, 2001.)

4.4.Impact assessment matrix

A five-step scale matrix has been created by the five project groups to assess the impacts of the development in Hammarbyskogen and Sjöstadshöjden (table 1).

The scale ranges from *Major positive impact* to *Major negative impact* with *No notable impact as* an interstage. The text on the right-hand side contains the instructions for the evaluation in our discussion. Every step is represented by a color. The colors are to be understood as in an ordinal scale, not representing a metrical scale.

The results of our evaluation are found in chapter 8. Summary of environmental impact assessment.

TABLE 1. THE IMPACT ASSESSMENT SCALE DEVELOPED BY THE PROJECT GROUPS WITH AIM OF ASSESSING THE IMPACTS OF THE DEVELOPMENT IN HAMMARBYSKOGEN AND SJÖSTADSHÖJDEN. THE SCALE RANGES FROM MAJOR POSITIVE TO MAJOR NEGATIVE.

Major positive impact	*Major positive impact on national, regional or municipal interests and objects. Alternatively, improvement of currently exceeded environmental quality standards, national guidelines or environmental thresholds.*
Minor positive impact	*A positive impact that does not constitute a Major positive impact.*
No impact	*No notable impact.*
Minor negative impact	*A negative impact that does not constitute a Major negative impact.*
Major negative impact	*Major negative impact on national, regional or municipal interests and objects. Alternatively exceeding environmental quality standards, national guidelines or environmental thresholds; or clearly worsen currently exceeded environmental quality standards, national guidelines or environmental thresholds.*

5. Description of proposed plan

The following chapter is based on the official Program, made by Stadsbyggnadskontoret (Program for Hammarbyhöjden och Björkhagen, 2016). Unless otherwise stated, that plan was used as the source of information. The Program was approved 2016-06-16 by the City Building Council ("Stadsbyggnadsnämnden"). However additional opinions concerning the size of the road was added to the decision protocol.

5.1.Hammarbyskogen

Hammarbyskogen is one of the green areas separating Hammarbyhöjden from Hammarby Sjöstad. A part of Hammarbyskogen connects to the west to residential areas of the western rim of Hammarbyhöjden. West of the Cholera park, one of Stockholm's biggest public transport hubs Gullmarsplan is located.

A narrow green corridor of Hammarbyskogen runs along Hammarbyvägen and is the closest connection (via Hammarbybacken and Hammarbyvägen to Årstaskogen. To the east, Hammarbyskogen is connected to Nackareservatet. The development of Hammarbyskogen is a small part of the larger strategic plan to connect Hammarbyhöjden with Hammarby Sjöstad (Stadsbyggnadskontoret, 2016). Figure 2 shows the two development areas, Sjöstadshöjden in northwest, close to Hammarbyvägen, where the narrow green corridor runs today and Hammarbyskogen in the southeast of the forest area. It has also been pointed out that the area should be developed more closely towards the Gullmarsplan-area and the coming renewal of the Globen/Slakthuset area (Comprehensive Plan for Stockholm, 2010).

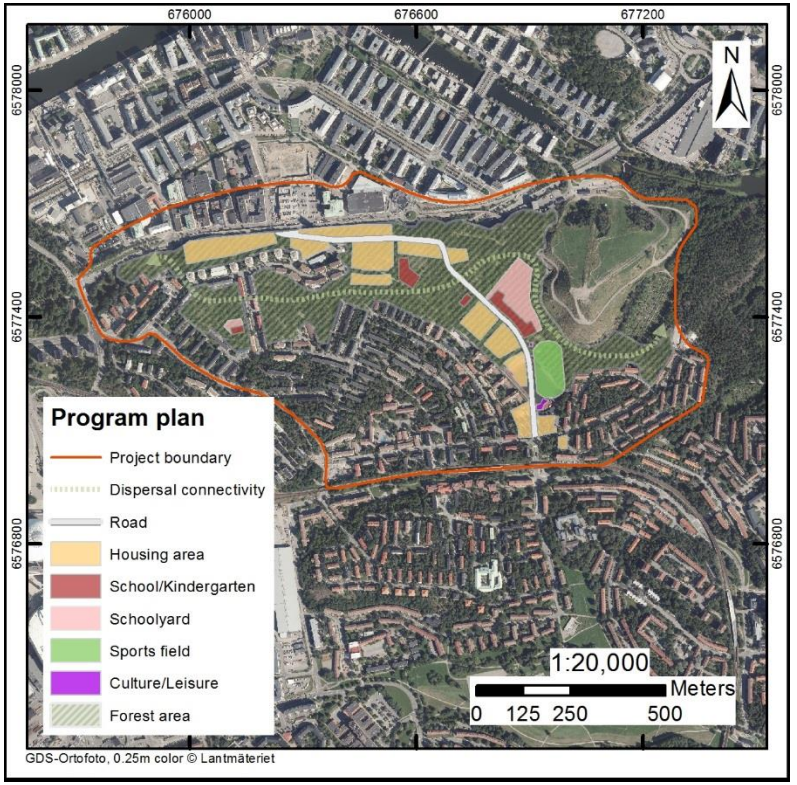


FIGURE 2. OVERVIEW OF THE PLANNED DEVELOPMENT IN THE PROJECT AREA. HOUSING AREA IN THE NORTHWEST, CLOSE TO HAMMARBYVÄGEN REPRESENT THE DEVELOPMENT OF SJÖSTADSHÖJDEN WHILE THE HOUSING AREA IN THE SOUTHEAST REPRESENT THE DEVELOPMENT OF HAMMARBYSKOGEN.

5.1.1. Development

The proposed development in Hammarbyskogen consists of 400 - 500 apartments (approximately 4 - 7 floors), one to two preschools and one elementary school (figure 3). New residential housing units should be developed parallel to existing houses alongside Per Lindeströms väg. Buildings would also be developed at locations that today are occupied by the

large sports field and a preschool (Kv. Sjöfararen). The bottom floors should be reserved for activities such as small stores and cafés. Buildings should be fit into the existing topography as well as to existing natural values. Public pathways should be developed between the blocks leading to the larger natural areas.

Most public functions, like one preschool, elementary school, the sports field and the playground should be placed on the eastern side of the new road. Other preschools would be located on the western side of the new road close to Lejonberget and Solberget.

FIGURE 3. THE DEVELOPMENT OF HAMMARBYSKOGEN WHICH INCLUDES 400 – 500 APARTMENTS, ONE TO TWO PRESCHOOLS AND ONE ELEMENTARY SCHOOL. TOVAT ARCHITECTS AND PLANNERS, 2016, 39.

Additionally, two blocks would be developed at the crossroad of Finn Malmgrens Väg and Ulricehamnsvägen. These two blocks would form an entrance, to the newly developed area (which would be named Hammarbyskogen) and Nackareservatet, as well as the re-designed sports field.

5.1.2. Nature and parks

In connection to Solberget and Lejonberget, a park would be developed. The park should act as a public meeting point, but still take nature, dispersal connection and core areas of oak into consideration. Both Solberget and Lejonberget would be preserved and developed as green "target areas". To complement Indianparken, one suggestion is to develop Solberget as a theme-park.

The development of Hammarbyskogen is planned to secure natural values by preserving the trees and the topography to the largest extent possible. Valuable oak-areas are to be preserved if possible. To keep the existing dispersal connection between Nackareservatet and Årstaskogen, a green corridor (30 - 80 meters) close to Solberget and Lejonberget will be preserved.

5.1.3. Sports field, playground and garage

The original sports field (Hammarbyhöjdens IP) will be replaced by a new sports field, that will be relocated closer to Hammarbybacken. The playground called Indianparken will also be moved further east. Underneath the sports field a garage will be developed. In connection to the sports field, space will be left for further development, for example the development of a heat cabin and locker rooms.

5.1.4. Roads

The project also includes the construction of a new road. The road (presented in the proposed plan) is an extension of Ulricehamnsvägen beginning at the intersection from Finn Malmgrens väg. The road would divide Hammarbyskogen and connect Hammarbyhöjden to Hammarby Sjöstad down by Hammarby Fabriksväg/Hammarbyvägen. The width of the road should not be larger than necessary to keep the effects on the natural values to a minimum. Still the road is supposed to support pedestrians, cyclists as well as car- and bus traffic, and would need to be 14.5 meters wide (figure 4).

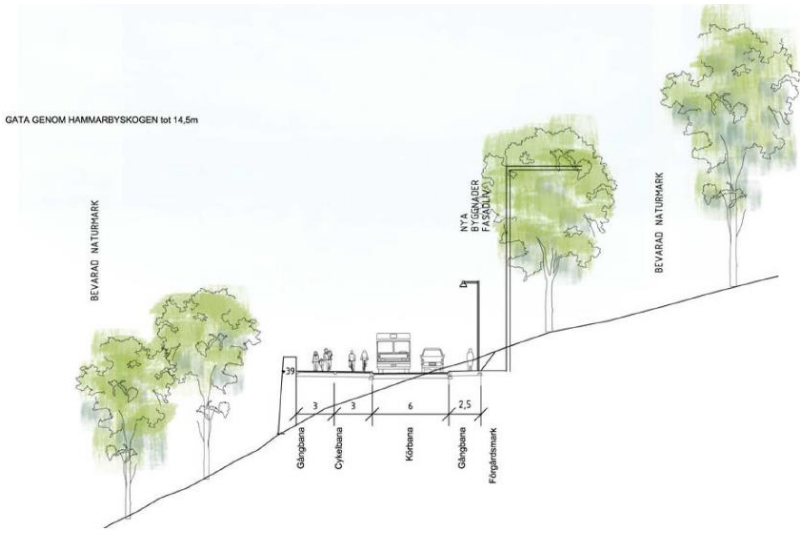


FIGURE 4. DEVELOPMENT OF HAMMARBYSKOGEN AND THE NEW ROAD (14.5 METERS WIDE) WHICH WILL CONNECT HAMMARBYHÖJDEN WITH HAMMARBY SJÖSTAD. TOVAT ARCHITECTS AND PLANNERS, 2016, 37.

5.2. Sjöstadshöjden

The development of Sjöstadshöjden is another part of the larger plan to connect Hammarby Sjöstad and Hammarbyhöjden. A transformation of Hammarbyvägen and Hammarby Fabriksväg would be necessary for the development of Sjöstadshöjden, since the two roads pose as large mobility barriers.

Sjöstadshöjden is still under investigation and how the area could be developed is yet to be determined (Exploateringskontoret, 2016). The transformation of the two roads is the major interference for the project to be able to move forward. How the roads should be transformed needs to be studied more in detail as well as where the new road through Hammarbyskogen will connect (Stadsbyggnadskontoret, 2016).

5.2.1. Development

The development of Sjöstadshöjden will consist of 550 - 650 residential apartments as well as one to two preschools (figure 5). The development of Sjöstadshöjden would decrease the barrier effect that Hammarbyvägen and Hammarby Fabriksväg today constitute. How to integrate the new housing units with the existing buildings is of high importance when continuing with the planning process. Buildings will be placed along both sides of the new road that will go through Hammarbyskogen as well as alongside the elongation of Kalmgatan. The location of the preschools is to be decided during the detailed planning process.

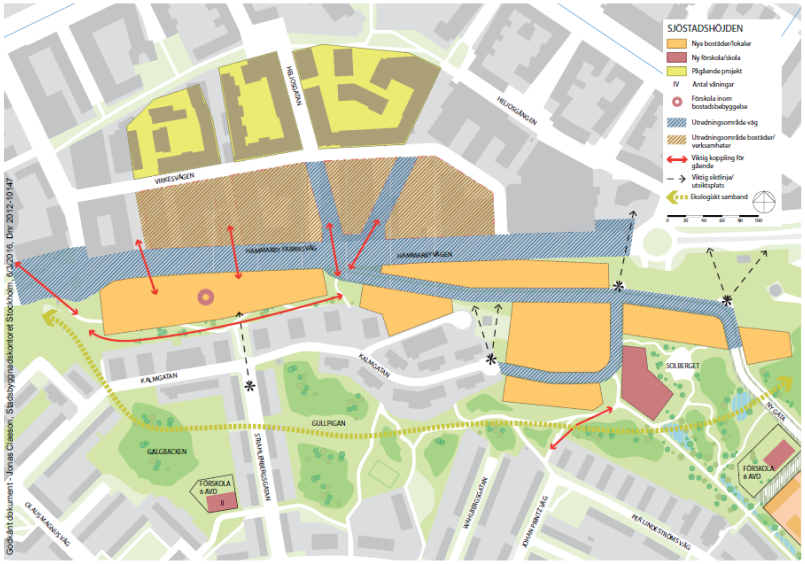


FIGURE 5. DEVELOPMENT OF SJÖSTADSHÖJDEN WHICH WILL CONSIST OF 550 – 650 APARTMENTS AND ONE TO TWO PRESCHOOLS. TOVAT ARCHITECTS AND PLANNERS, 2016, 35.

5.2.2. Roads

A transformation of Hammarbyvägen is necessary to connect Hammarbyhöjden with Hammarby Sjöstad. This aim can be reached by making the road a city street, decrease noise as well as increase air quality for both new and existing houses is important in the planning of Sjöstadshöjden. For this to be possible a solution of how to treat transport of dangerous goods is necessary. Today Hammarbyvägen and Hammarby Fabriksväg are used for transport of dangerous goods. The roads are also used to redirect traffic from Södra länken. This therefore limits the development since the city has demands to be able to guarantee safety for residents in the area.

Another aim in the program is to increase the crossings for pedestrians and cyclists to decrease the barrier effect of Hammarbyvägen. And also to preserve and develop the bicycle-lane between Gullmarsplan and Sickla that runs parallel to Hammarbyvägen today.

To be able to develop housing at the crossroad of Mårtensdals-gatan the roundabout, Hammarbyvägen-Textilgatan, is planned to be converted to a three-way-roundabout.

The new road that would be developed through Hammarbyskogen should connect to Kalmgatan as well as one of the main streets in Hammarby Sjöstad. This should increase the accessibility between Hammarbyhöjden and Hammarby Sjöstad. Retaining walls and viewing points will be developed alongside the new road at suitable locations.

6. Description of alternative location

6.1. Alternative A

Alternative A includes alternative locations and is overall on a smaller scale compared to the proposed plan. The motive for alternative A is to save more of the recreational- and ecological values, as they are found to be some of the most important features of the area. The aim with alternative A is to leave as much of the coherent forest as possible as well as preserving both natural values and recreational opportunities. Alternative A does not prevent a development in Hammarbyskogen instead it tries to combine the need for preserving the forest with the big need for apartments, schools and preschools in Stockholm. The planned road that would divide Hammarbyskogen is not included in alternative A since it is believed to cause negative impacts. (see chapter 8. Results).

The old pipes are distributed along the street Olaus Magnus väg and at Malmövägen/Ystadvägen to the southwest of

Hammarbyskogen and in the north of the SL depot. Since the pipe system tend to leakage in some parts, preparation work will be implemented to avoid pollution of the groundwater and vegetation in the surrounding area.

For the buildings along Hammarbyvägen the risk of accidents with dangerous transport goods is considered to be very small, but the effects are uncertain and need further investigation.

As eastern part of Hammarbyskogen and Sjöstadshöjden have slightly different conditions in terms of possible alterations in design and height of the buildings, the areas are divided into different sections for a better visualization.

5.1.1 Eastern part of Hammarbyskogen

This alternative includes about 200 - 250 apartments in total. The sports field is proposed to be tilted eastwards in comparison to the program document and the elementary school is adjusted accordingly. Preferably the schoolyard could be designed to hold much of the original forest surroundings with lesser paved surface. Three separate 6-8 storey buildings with approximately 75 apartments would then replace the buildings in the proposed plan along the bicycle lane close to the block Sjöfararen. This would have a considerable positive impact on the amount of nature preserved compared to the proposed plan. A wider, new 5-storey building with around 40 apartments should be reconsidered on the utmost corner of the Finn Malmgrens väg/Ulricehamnsvägen which is the western part of Willy Brandt park (figure 6). Most of the park area will be preserved.

Playground areas can be found in the new location of Indianparken and along the forest area to Nackareservatet.

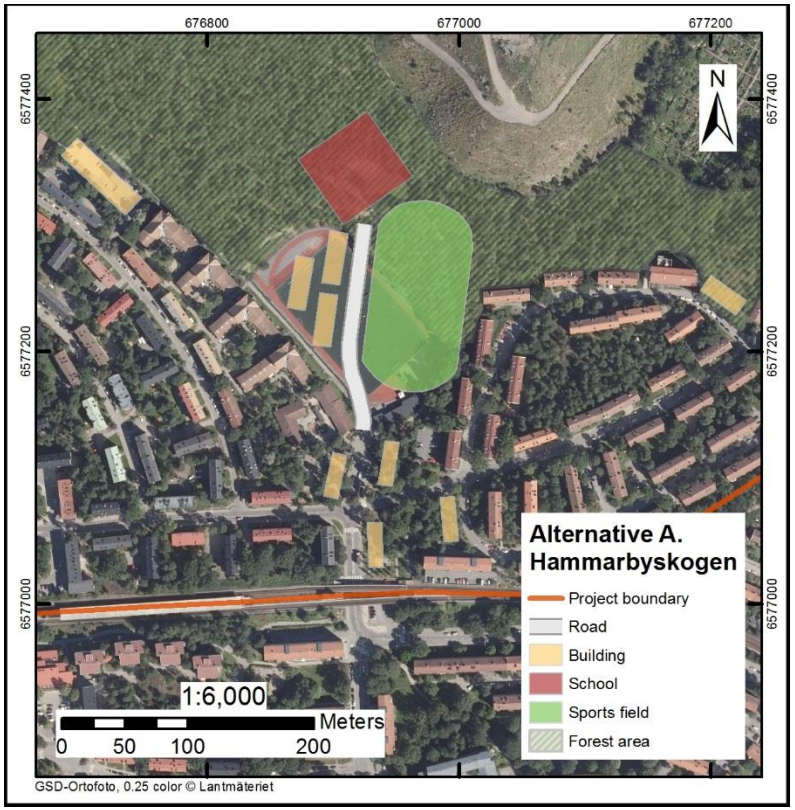


FIGURE 6. ALTERNATIVE LOCATION OF THE DEVELOPMENT IN EASTERN PART OF HAMMARBYSKOGEN. THE DEVELOPMENT WOULD INCLUDE 200 – 250 APARTMENTS AS WELL AS ONE ELEMENTARY SCHOOL.

5.2.1 Sjöstadshöjden

Alternative A includes in total about 350 - 400 apartments (figure 7). The location of the preschool at Galgbacken has not been altered in comparison to the proposed plan. To keep the environmental impact relatively as low as possible, alternative A suggests that the apartments should only be built along Hammarbyvägen. Therefore, less of the forest area will be used in alternative A compared to the proposed plan. Also, the

existing green corridor along Hammarbyvägen would be better preserved. proposed plan. Along Hammarbyvägen, eight 10-story residential buildings with 40 apartments in each building is suggested.

An access road along the buildings would provide access to and from Hammarbyvägen. A road for pedestrians and bicycles would be needed. This road should be connected to the existing pathway passing the Tele tower and continue to the planned elementary school and the sports field in the Eastern Hammarbyskogen. As much of existing paths should be used for this. From the roundabout on Hammarbyvägen/Textilgatan an access road should be built along Hammarbyvägen for accessing the proposed eight buildings. Between the buildings it is recommended to locate some benches and create a parklike atmosphere in harmony with existing trees.

According to our findings, noise is an issue in this area today (see chapter 7.9 Noise). To reduce traffic noise between the access road and Hammarbyvägen, noise protection wall should be installed. A noise protection wall reduces the noise by up to 20 dB. For even higher quality of the buildings and to ensure that they meet the noise requirements for indoors environments it is recommended to install soundproofing windows. Depending on the classification, windows are able to reduce noise by up to 50 dB.

In alternative A, one residential 4-storey building with 15 apartments can be built in the east ending of Kalmgatan. With this location, Kalmgatan needs to be extended to reach the new buildings in the east.

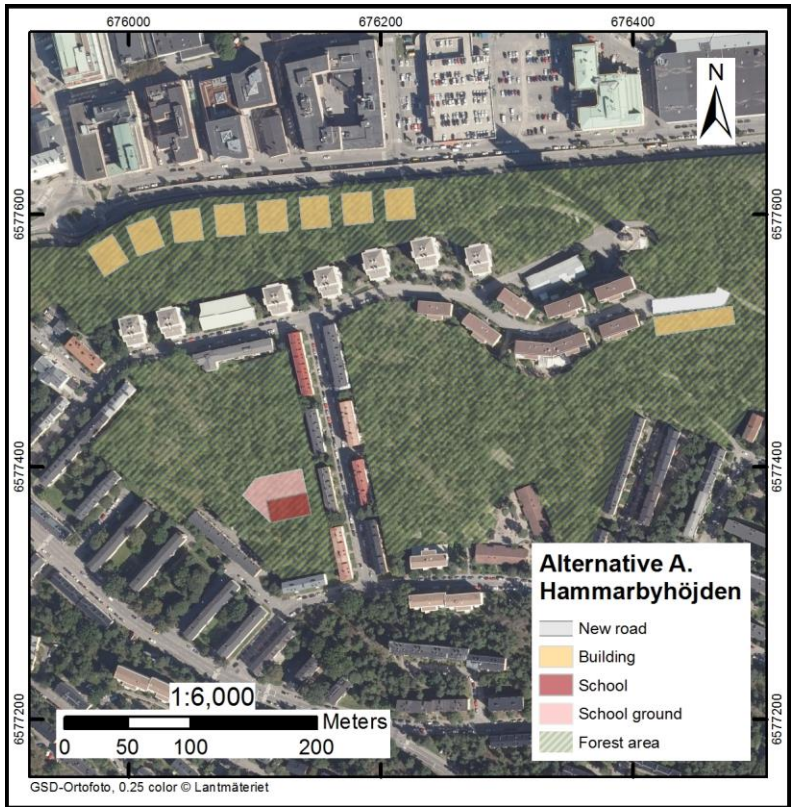


FIGURE 7. ALTERNATIVE LOCATION OF THE DEVELOPMENT IN SJÖSTADSHÖJDEN. THE DEVELOPMENT WOULD INCLUDE 350 – 400 APARTMENTS AS WELL AS ONE PRESCHOOL.

The facade of these buildings could be made of wood as in (figure 1 in appendix B) to create a better atmosphere with the natural surroundings. In the appendix are some other ideas how the towers along Hammarbyvägen could be designed to minimize the disturbance of the forest (figure 2 and 3 in appendix B).

5.2.2 Potential modification of alternative A

There are some modifications to consider for alternative A, which are presented below.

By reducing the sports field to half of the size it would increase the possibility to build two more buildings with approximately 50-70 apartments. There is a pronounced need for full size sports field in Stockholm. It should be investigated if the existing sport fields at Kärrtorp IP could be an alternative instead (just 1.5 km away). There is also a new indoors multisport hall planned at Nytorps gärde, which could be used later on.

For a possible increase of the green corridor along Hammarbyvägen, the buildings could be built directly along Hammarbyvägen having an elongated design instead of tower squares. This could also increase the number of apartments. In order to this, the windows need to have soundproof windows of class 6 to decrease the noise for about 50 dB. There is probably an ever greater need putting Hammarbyvägen in a tunnel.

To increase the number of apartments in alternative A, one or two houses could be built at the corner of Hammarbybacken/ Hammarbyvägen. This land has flat topography and could be a reliable fundament to build on. It is easily accessible, because the area is directly located besides the existing road. The existing tree line to existing residential buildings could be kept. Today there is a lawn and a couple of bushes and trees growing on this location. The connectivity between Hammarbyskogen and Årstaskogen will be affected in a negative way. This location must be investigated further to secure the existing connectivity, which today is low. In order to build on this space, the noise levels would also have to be considered and mitigation measures would probably be required.

7. Environmental baseline, impact assessment and mitigation measures

7.1. Vegetation (Flora)

7.1.1. Baseline

Hammarbyskogen is dominated by coniferous forest, which mainly consists of old populations of pine. This vegetation type is common in the green areas of Stockholm, but is generally rare internationally. Other trees that occurs in this forest are oak, hazel, aspen, birch, elm, ash, spruce, sallow and wild cherry. The structure of Hammarbyskogen is characterized by a diversity of old trees, hollow trees, valuable dead trees, wood bog areas, small wooded wetlands, boulder slopes and rock outcrops. All these different structures create a mosaic of different suitable habitats for a diversity of species. Hammarbyskogen therefore have the ability to bear a large diversity of species that are worth protecting (Nyréns Arkitektkontor, Ekologigruppen, Atkins 2013).

The forest area of Sjöstadshöjden is a mix between broad-leaved deciduous forest and mixed forest with streaks of older oak and pine trees as well as individual trees of ash (near threatened) (Ekologigruppen 2015).

Hammarbyskogen, as well as Sjöstadshöjden, connects to Nackareservatet in the east and Årstaskogen in the west. This connection constitutes a corridor for migrating wildlife species. Both areas are therefore very important parts of the ecological network in the south of Stockholm (Ekologigruppen, 2013). The wooded wetlands in Hammarbyskogen, with open water during certain periods of the year, are of great importance for amphibians, insects and birds (Nyréns Arkitektkontor, Ekologigruppen, Atkins 2013; Ekologigruppen 2015).

Hammarbyskogen also provides ecosystem services. For example, the vegetation helps to prevent floodings and sharp fluctuations of temperature and humidity.

The two parasitic species, White Speck (*Phellinus pini* – "Tallticka") and Oak Fungus (*Phellinus robustus* – "Ekticka"), have been found in Hammarbyskogen. The two species are dependent on the presence of older trees. Both species are classified as "near threatened" in Sweden and are therefore worth protecting (Ekologigruppen, 2015).

7.1.2 Impacts during construction phase

During the construction phase, large impacts on the forest could be expected. Green areas would be either permanently removed to make space for development or reduced and replaced by short- or long term construction sites. Roads through the forest would have to be prepared and would be heavily trafficked. This would cause further stress on the environment. Even where different phases in construction would be limited in time, the effects on the environment would in many cases last for years. Green space that is in close proximity to development areas might have to be removed and replanted.

7.1.3 Consequences during operation phase

The exploitation of Hammarbyskogen and Sjöstadshöjden would lead to a great loss of vegetation in favor of residential housing and schools. The new road would decrease vegetation further. Moreover, the development of a park area would replace the original forest with planted trees. The changes in environment would not only decrease the area of vegetation, it would also decrease the diversity of vegetation types.

Areas of valuable wetlands and oak areas may be lost or negatively affected through the development. Furthermore, the project would cause fragmentation of Hammarbyskogen, and in the development in Sjöstadshöjden, large areas of forest would be erased (Ekologigruppen 2015).

A loss of important habitats follows the deprivation of different vegetation types. These could lead to a decreased species richness. The new road would constitute a barrier for species dispersal. The fragmentation that follows from the development of Hammarbyskogen and Sjöstadshöjden would increase any negative effect on species' dispersal ability even more. The exploitation of Hammarbyhöjden and Sjöstadshöjden would most likely have a negative effect on the populations of older trees such as oak and pine. Such a loss of old trees could cause a decline in the populations of the two fungi species White Speck and Oak Fungus that are classified as near threatened (Ekologigruppen 2015).

7.1.4 Mitigation measures for proposed plan

Valuable areas are suggested to be left undeveloped. If possible, these areas should be connected to strengthen the dispersal connection between Nackareservatet and Årstaskogen. Valuable wetlands should also be preserved in accordance with the national environmental objective *Thriving wetlands.* A management plan for both wetlands, the preserved forest as well as the developed park area should be compiled.

To decrease the impact on biodiversity, older trees, dead wood and specific valuable individuals of trees should be preserved. In the planned park area, it is recommended to plant a diversity of species. Trees and bushes that bloom during spring and bear fruit in the fall would attract animal species to the area, such as pollinating insects, birds and bats.

By planting or preserving trees on both sides, parallel to the new road, the barrier effect on migrating species as well as the impacts from fragmentation could be decreased. Passages for

smaller species under the road should be installed along the road.

By offering services such as possibilities of cultivations and gardening, species richness could be increased (Ekologigruppen 2015). If mini garden plots are placed on balconies or on roof terraces, they would also function as green area compensation (Olsson, 2016).

7.1.5 Consequences from zero alternative

Without the development in Hammarbyskogen and Sjöstadshöjden, the forest area would be preserved in its present state. Therefore, no effects on the dispersal connection can be anticipated. The species diversity is likely to be preserved. Over time old trees will age and increase in value. However, the wear on nature from human activities will continue. When nearby areas are developed and densified, more people can be expected to visit the forest. Therefore, an additional pressure on the forest can be anticipated.

7.1.6 Consequences from alternative A

By exploiting Eastern Hammarbyskogen and Sjöstadshöjden according to alternative A, a large area of vegetation will be lost. By developing these two areas there is a risk of decreasing the diversity of flora as well as a reduction of ecosystem services, e.g. the natural temperature adjustments (see 7.10 Air and Climate). Areas of deciduous trees as well as valuable individuals of old oak, pine and ash trees in Sjöstadshöjden may be lost. The exploitation of Eastern Hammarbyskogen will affect areas with old oak, pine as well as valuable areas rich in dead wood. Depending on how the development of the school yard will evolve, the effects on the forest may be greater.

The forest area of Sjöstadshöjden is important for the dispersal of species between Nackareservatet and Årstaskogen. Even though the development of Sjöstadshöjden preserves a green corridor for species to be able to move along, this will weaken the connection between the areas (Nackareservatet and Årstaskogen).

The development of Sjöstadshöjden and Eastern Hammarbyskogen may lead to a loss of habitats due to the reduction of forest and the decreased diversity of vegetation. The loss of habitats could cause a decreased species richness.

7.2.Fauna

7.2.1. Baseline

Crested tit (*Lophophanes cristatus* – "Tofsmes"), insects on oak and toad (not specified) are considered to be indicators of how strong the ecological connection is between broadleaved, coniferous forest and wetlands in Stockholm. The connection between Nackareservatet and Årstaskogen is interrupted for both amphibians and insects, but can still exist for birds. Other species living in the area is for instance Greater woodpecker (*Dendrocopos major* - "Större hackspett"), Lesser spotted woodpecker (*Dendrocopos minor* - "Mindre hackspett") which is near threatened, Willow warbler (*Phylloscopus trochilus* - "Lövsångare"), European robin (*Erithacus rubecula* - "Rödhake"), Common redstart (*Phoenicurus phoenicurus* - "Rödstjärt"), Goshawk (*Accipiter gentilis* - "Duvhök") near threatened, Nuthatch (*Sitta europaea* - "Nötväcka"), Blackcap (*Sylvia atricapilla* - "Svarthätta") and Treecreeper (*Certhia familiaris familiaris* - "Trädkrypare") (Artportalen, 2016a).

Great Crested Newt (*Triturus cristatus* - "Större vattensalamander"), which is included in Species Protection Ordinance (Artskyddsförordningen 2007:845), was in 2010 found at the nearby area Skogskyrkogården. It was also found before the development of the sports field in Johanneshov

during the 1960s. The Smooth Newt (*Lissotriton vulgaris* - "Mindre vattensalamander") has been found in Hammarbyskogen (Lindberg, written communication, 2016-12-09), which also might be a good habitat for the Great Crested Newt. Although, no inventories of amphibians have been carried out in Hammarbyskogen (Artportalen, 2016b).

Grass snake (*Natrix natrix* - "Snok") and toad (not specified) are examples of species worth protection in the area. These are depending on the presence of a mosaic of different moist environments (Gröna strategier 2015).

Ecosystem services in form of insect pollination is considered to be good (Ekologigruppen 2013).

7.2.2. Impacts during construction phase

The planned development in Hammarbyskogen would result in buildings occupying the area, which today form habitats for species. This would lead to habitat loss and fragmentation, which in turn would result in a decreased animal diversity. Noise from the construction would also disturb species living close by.

7.2.3. Consequences during operation phase

The development of buildings and the road would cause fragmentation to habitats and limit the dispersal ability for species that are living in the forest (Stadsbyggnadskontoret, 2012). When old populations of trees disappear, the species that depend on those trees would also be lost. The loss of habitats would most likely result in a reduction of biodiversity, since biodiversity is dependent on the size of the areas (Ekologigruppen, 2015). New residents and more traffic would lead to an increased noise level, which would disturb animals living in Hammarbyskogen. This might lead to some species moving further away from the area to avoid human activity. The exploitation of Sjöstadshöjden forces species dispersal onto a different route where animals will not only have to cross the new road, but also Kalmgatan and Strahlenbergsgatan (Ekologigruppen, 2015).

7.2.4. Mitigation measures for proposed plan

It is important to adjust the location of buildings to minimize the habitat intrusion and try to keep as much as possible of the green corridor. Plants that are chosen to be planted in the parks (and possibly on green roofs) should be beneficial for ecosystem services such as insect pollination. Wetlands and wetter habitats that are important for amphibians and insects in the area should be preserved and managed. Older trees are valuable for a number of species and should therefore be saved.

7.2.5. Consequences from zero alternative

Without the proposed plan for Hammarbyskogen and Sjöstadshöjden the forest will be spared. No loss or fragmentation of habitats would preserve the biodiversity in the area. The connection for species dispersal between Årstaskogen and Nackareservatet would be preserved. It could however be negatively affected by an increased number of visitors when other nearby building areas are constructed.

7.2.6. Consequences from alternative A

The development of buildings in the green corridor will limit the dispersal ability for species that are living in the forest, even though more is left of the corridor compared to the proposed plan. This alternative would also result in an increased noise level from the school, which could disturb animals living in Hammarbyskogen. This alternative might therefore still lead to some species moving further away from the area to avoid human activity. However, more space is left behind the school compared to the proposed plan, to facilitate the passage for

animals. The schoolyard could be designed to have lesser paved surfaces. By this, the schoolyard could act as a part of the green corridor.

In this alternative, there is no development of a new road in the forest to reduce habitat fragmentation. Neither is the residential houses in the core of the forest suggested in this alternative, which would decrease the harm to biodiversity that the fragmentation would result in. The alternative would also mean less residents in the forest that could disturb the animals living there, compared to the proposed plan.

7.3.Cultural heritage values

7.3.1. Baseline

An investigation of the cultural heritage values was made by Nyréns Arkitektkontor (2015) in preparation for the program plan. According to the consultants, Hammarbyhöjden and Björkhagen represent developments in urban planning during the 1930s, 40s and 50s (figure 8). These residential areas were planned as a protest against densifying the inner city areas and the leading idea was that of the "Garden city". Hammarbyhöjden was one of the two earliest areas to be built in between the city and the forest. Another municipal time ethos was to build houses for the growing population suitable for larger families, also known as "barnrikehus".

The observations/fieldtrips show that the streets follow the topography of the area. Slopes and edges consisting of uncovered stone can be found in many places throughout the neighborhood. Instead of saving trees in larger park-like areas, natural trees are evenly spread out around buildings and they often rise above the three-storey buildings.

FIGURE 8. A BUILDING IN HAMMARBYHÖJDEN CHARACTERISTIC FOR THE DEVELOPMENT OF HAMMARBYHÖJDEN AND BJÖRKHAGEN THAT OCCURRED DURING THE 1930S. 40S AND 50S.

Following known guiding principles for evaluation of cultural heritage values (see Unnerbäck, 2012), we find that Hammarbyhöjden has both cultural history values and social history values connected to the architecture and the identity of the area.

As it is shown in the Stockholm City Museum's inventory of cultural heritage values (figure 9), a new ring of buildings was added into the forest in the 1980s, north of existing buildings. This addition is not yet classified and cannot be said to contain any significant cultural heritage values (Stadsmuseet, 2016).

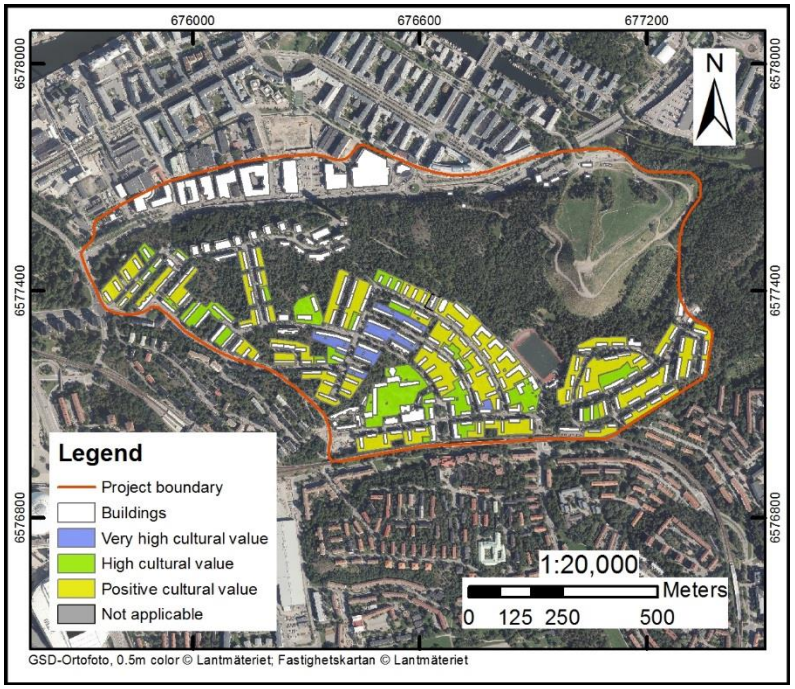


FIGURE 9. STOCKHOLM CITY MUSEUM'S INVENTORY OF CULTURAL HERITAGE. BUILDINGS MARKED IN BLUE ARE OF VERY HIGH CULTURAL VALUE, GREEN BUILDINGS ARE OF HIGH CULTURAL VALUE AND YELLOW BUILDINGS ARE CLASSIFIED AS POSITIVE CULTURAL VALUE. WHITE BUILDINGS ARE NOT YET CLASSIFIED.

7.3.2. Impacts during construction phase

Vibrations from blasting and heavy traffic could have harmful effects on buildings. No other impacts can be expected that would lead to physical changes during the construction phase.

7.3.3. Consequences during operation phase

The meeting between new and old buildings requires special sensitivity for the existing cultural environment, otherwise there is a risk of destroying the surroundings' natural values or buildings' architectural values. The high values exist because of the clear historical layers that still today can be easily followed (marked in blue in the map above, figure 9). However, a new ring of buildings added in the pointed out areas in the proposed plan should not cause any significant changes or decrease in relevant values. Though, the natural values in between the 1930s - 1940s buildings of the area are also of importance. If not to change the impression of the cultural environment, the naturally developed nature needs to be kept around the houses.

The placement of new housing units in between Hammarbyskogen and Hammarby Sjöstad in Sjöstadshöjden would connect to the newer buildings from 1980s-1990s and would not intrude on the area of high cultural heritage value.

According to the inventory made by Nyréns arkitektkontor (2015, 8) the topographic mix of houses and nature contribute to the special landscape in Hammarbyskogen. They write that if high buildings were placed in too close proximity, they would risk a decrease in experience values. When developing, the height of the surroundings with the landmark of Hammarby ski slope should also be considered.

7.3.4. Mitigation measures for proposed plan

Sensitivity towards cultural heritage needs to be observed to maintain current values. If new residential housing is added to Hammarbyskogen, they need to be added in enclosed areas, not to devalue the comprehensive impression of existing buildings.

7.3.5. Consequences from zero alternative

If the development in the proposed plan is not followed through with, no changes to the residential area can be expected. Many of the houses are currently undergoing large renovations (field trip investigation, 2016-12-08), which is an indicator for them to keep their value.

A potential problem could be that if the housing shortage continues at current levels or even increases, the need for densification in the City will also rise. The proposed plan takes a comprehensive look on possible locations for development. However, if the plan is rejected, new buildings could potentially be introduced into the area in a more haphazard way. Such a development would have a much more damaging effect on cultural heritage values than current plans.

7.3.6. Consequences from alternative A

If the alternative location in eastern Hammarbyhöjden lies closer to existing buildings, more care should be taken to make sure they fit into today's location. This limits the potential height for some of the buildings. The development in Willy Brandts park would remove one of few open areas with public art that exist in the area. Though, the increased development in Sjöstadshöjden would not have any effects on cultural heritage values.

7.4. Green areas and recreation

7.4.1. Baseline

According to Ekologigruppen (2015), the area of Hammarbyskogen has a character of nature- and outdoor life and is considered to be a green meeting place. There is a wide range of pedestrian and bicycle paths in the forest that is frequently used by joggers, dog owners, preschool groups and for walking. A popular playground, Indianparken, is also located in the forest. The forest is separated from roads and traffic, which gives the children great freedom of movement. The forest is also used for educational activities. The social values in the area is for example the feeling of nature, nature experience, walks, picnics and peacefulness. These values are considered to be indicators for life quality (Ekologigruppen, 2015).

In "Områdesanalys Hammarbyhöjden - Björkhagen" (Nyréns Arkitektkontor, Ekologigruppen, Atkins, 2013) it is mentioned that the recreational values in Hammarbyskogen need to be preserved and secured through long-term management and development. It also states that the rock outcrops and viewpoints toward the north should be made more available by means of a walking trail in the preserved natural environments along the cliff edge.

Many of the residents in Hammarbyhöjden and Björkhagen moved here to get closer to the nature (Ekologigruppen, 2015). The pressure on the forest from recreational activities are quite high which is wearing on Hammarbyskogen (Rädda Hammarbyskogen, Lindberg, Personal communication, 2016-12-09).

7.4.2. Impacts during construction phase

The playground Indianparken would have to be replaced and moved towards Hammarbybacken to make room for new residential housings. Cranes and tractors will occupy space and can disturb the nature experience. While the construction is ongoing, recreation areas would be less accessible and could be less safe. The activities on the sports field would have to be relocated to other areas or cancelled during its reconstruction.

7.4.3. Consequences during operation phase

During the work with the plans the balancing principle ("Balanseringsprincipen") has been working as a guideline. This principle means efforts to prevent and minimize changes to natural environments (Ekologigruppen, 2015). However, the development of buildings and infrastructure in the area will lead to less green recreational area. Many studies indicate that exposure to nature is positively linked with human health - both psychological- and physiological health (Sandifer et al., 2015).

The part of the forest that will be preserved is significantly smaller than the original forest and it will also have more of a park-like character. This could lead to a less genuine feeling of nature for visitors, which affects the recreational value of the forest negatively. A transformation of the forest to a more park-like area could on the other hand increase the accessibility for elderly and people with disabilities and perhaps increase the feeling of safety.

The development would probably result in more people visiting Hammarbyskogen, which in turn could lead to a bigger wear on the nature that is left. According to Gröna Strategier (Ekologigruppen 2015), Hammarbyskogen is important for the health and wellbeing of residents, since there is no other designated area for activities that is taking place in the forest (spontaneous sports, relaxation etc.). Furthermore, the access to silent places, which is an important aspect in the Comprehensive Plan for Stockholm (2010), would be affected negatively for the residents in the area.

The plans mention the importance of improving the entrances to Nackareservatet making it more visible and accessible (Stadsbyggnadskontoret, 2016). In the Stockholm environmental program, it is recommended that the distance to the nearest green area is no longer than 200 meters (Stadsledningskontoret, 2016), and the path to that green area should be clear and accessible, especially for children. These conditions would not be fulfilled if Hammarbyskogen disappears or becomes inadequate as a green area, since Nackareservatet lies more than 200 meters from many residential areas. Furthermore, the entrance to Nackareservatet that is closest to Hammarbyhöjden, east of Hammarbyskogen, lies on a steep ascent and is thus unavailable for disabled people and elderly.

7.4.4. Mitigation measures for proposed plan

To reduce the adverse impacts on children's recreation, the new playground should be made ready before removing the present one. Safe paths to the new playground, that can be used by children during the construction, should be created. A managing program to keep the part of the forest that is left in a good shape could prevent some of the negative impacts from higher pressure and wear of the forest.

7.4.5. Consequences from zero alternative

If the development projects in Hammarbyskogen and Sjöstadshöjden are not realized, the forest would continue to be a popular recreational area, like it is today. It would continue being the closest green area for residents in Hammarbyhöjden, and a big asset for people in other areas. It is likely that the number of people visiting the forest would increase, since there are other residential developments carried out in the nearby area. Better connections and directions signs along Finn Malmgrens väg and Hammarbyvägen as well as inside Hammarbyskogen are recommended.

7.4.6. Consequences from alternative A

The exploitation suggested in alternative A would result in a loss of recreational area, since parts of the forest would be transformed into residential and school areas. The loss of forest area is smaller than in the proposed plan though. The forest area that is not exploited will be left as it is, not transformed into a park. This means that a large coherent forest area would still be there to provide the recreational values of nature feeling and tranquility.

7.5. Social aspects

7.5.1. Baseline

According to the proposed plan (Stadsbyggnadskontoret, 2016), Hammarbyhöjden mainly consists of residential housing, with only a few public services (grocery stores, cafés and restaurants) concentrated around centrum areas and subway entrances. In nearby Björkhagen, a medical center and a public library can be found. The City's office, responsible for the southeast Department Skarpnäck-area ("stadsdelsförvaltning"), is also located there.

There are 16 preschools and 2 elementary schools in the area. Even though, there is a need for an expansion, both of preschools and elementary schools. The proposed program shows that a number of them only have limited building permits and would soon need to be converted into permanent units (Stadsbyggnadskontoret, 2016). The document Skolplanering Stockholms stad from 2016.09.01 shows that the city department responsible for Hammarby Sjöstad is expanding *all* existing schools in their area already today. They count on the school in the proposed plan to be finished in year 2023. The document also shows that the Skarpnäck City Department school capacity and neighboring Enskede-Årsta-Vantör City Department's capacity both are rather low. Neither areas have many schools planned (Stockholms stad, 2016, 4). The planning process for schools usually takes a long time and the strategic planning for schools often even longer. Today the long-term planning for 2040 would create 11 000 new elementary school units. Another 24 000 units would be needed until 2040 and are not yet planned for (SAMS, 2016, 7).

The availability of sports facilities in the area is good. Access to playgrounds is relatively good, but for some residential housing units the distance to the closest playground is over 200 meters (Stadsbyggnadskontoret, 2016), which is not ideal and should be remedied. A way to do that is to upgrade existing parks and playgrounds, which has been proposed as an additional measure in the proposed plan.

Today there is only one service residence for elderly. It is situated near Hammarbyhöjden's subway station. However, in the long term, there will probably be a need for another residential home in the northern part of the program area.

7.5.2. Impacts during construction phase

During the construction phase, the sports field would be demolished and then rebuilt a short distance from its current location. This would mean that children using it today would have to be relocated to nearby sports facilities. This may pose a problem for a city that already experiences a severe lack of sports facilities for schools.

Preschool departments that have to be relocated or give up land during construction would also cause a reduction in preschool numbers' availability.

7.5.3. Consequences during operation phase

Today there is already a need for additional preschool- and elementary school units, which would have to be resolved in the area. The new elementary school that is planned in Hammarbyskogen would be able to take 1 000 students, both from Hammarbyhöjden and Hammarby Sjöstad. An additional preschool would also be connected to the new elementary school since the development in the proposed plan would remove the existing one (at Kv. Sjöfararen). An estimation is that two new preschool departments would be required per 100 additional built flats (Stadsbyggnadskontoret, 2016, 19).

Depending on the design of the planned road and the increase in traffic, the elementary- and preschool children would have to cross the new road that is placed just beside the school. There could be a risk of accidents.

According to the population forecast for the years 2014 to 2024 (Statistik om Stockholm, 2015, 84-85), the number of people in Hammarbyhöjden in the ages of 65-79 years is predicted to increase with 58 percent. There will also be an increase of children in the ages of 1-18 years, but the number of people of 19-44 years are predicted to decrease. Calculations are based on the people living in Skarpnäcks' City Department, consisting of East Hammarbyhöjden together with residents of Blåsut. The latter area is situated within the Enskede-Årsta-Vantör City Department. This is the smallest area for predictions concerning our area.

The County Administrative Board (Länsstyrelsen) writes in their annual report Läget i länet (2016) about the county's residential housing situation that since the housing shortage is high in all 26 counties, there are difficulties for many social groups on the housing market. A continuing increase in prices makes it especially hard for low-income groups to acquire new flats. The rental market is not in a good state with queues for 10 years or more. It can be expected that residents in most newly built housing units will be relatively well off. The costs of either buying or renting newly produced units are high, and to combat gentrification it is important that the City strives for an even mix of citizens, by producing a mix of different sizes of apartments. It is the municipality's responsibility to make sure that affordable housing is also being built, as well as apartments at market prices (Länsstyrelsen, 2016). This is done through negotiation between the municipality and developers and stated in the resulting development agreements.

Based on the County Administrative Board's (2016) report, if the inflow of residents with higher economic means increase in the area, it could not be expected that the development of the small amount of buildings in the proposed plan would result in significant changes in population size, age structure or cause any resettlement of communities. Neither can it be assumed that the inflow of new citizens should create any significant changes to social groups living in Hammarbyhöjden today.

However, as the inner-city expands outwards into the considered area, changes in demography will follow the same development patterns as in the rest of the city. The need for preschools, schools and sports' facilities will continue to rise, together with the demand for other social services. Full size facilities are few around the city and are used by sports clubs or other organizations in afternoons and evenings as well. In the City's budget for 2017, they state that the City is trying to increase the number of sports areas. Such planning takes a long time and their existence are important for many social goals (health aspects, integration, gender inclusion etc.) in today's growing city. Planning is made together with other city councils like Exploateringsnämnden, Stadsbyggnadsnämnden, Utbildningsnämnden, and with the municipally owned School Property Company SISAB (Budget, 2017).

7.5.4. Mitigation measures for proposed plan

The City would have to make sure that housing units for low-income households are produced. New preschool units could be made ready before demolishing current ones to make sure that parents and children can use them throughout the development phase.

7.5.5. Consequences from zero alternative

No development would lead to no negative impacts on social- and economic values.

Yet, over time experience Hammarbyhöjdens residential areas would have an increased need for schools, preschools and sports facilities. If the proposed development is not built, they would have to be built somewhere else. Preferably close by Hammarbyhöjden and Hammarby Sjöstad, otherwise children and youths would have longer commuting distances or distances where they would have to be driven by parents when going to evening activities.

7.5.6. Consequences from alternative A

The smaller number of apartments in alternative A would not cause any large effects on social aspects in the area. They would have to be built in another location close by. The development would have to make sure to include mix of both residential and local services. Otherwise the area will stay a strict residential area where the citizens mainly commute to other areas to work.

7.6.Traffic

7.6.1. Baseline

There are three entrances to the area, which do not clearly show that the visitor enters from one neighborhood into another. They are also lacking in clear directions. The metro Hammarby Fabriksväg, Nynäsvägen and other big infrastructures in the area are forming barriers together with the fault scarp. This barrier hampers the movement for the residents between districts (Stadsbyggnadskontoret, 2016).

There is a well-developed network of pathways and bicycle tracks in the area, even though many of them today are too narrow compared to the required standards. Another problem is that it can be difficult to orientate oneself on some of the paths. Furthermore, some paths through green areas are not adapted to be available for people with disabilities for example. The metro railway is often a hinder for the bicycle traffic since it is hard to cross it by bike. There are also insufficient possibilities to reach the area from others parts of the city by bike (Atkins, 2014).

The car traffic in Hammarbyhöjden-Björkhagen consists mostly of the inhabitants of these areas. Though, Hammarbyvägen is a busy street which forms a barrier for pedestrians and cyclists between Hammarbyhöjden and Hammarby Sjöstad. Hammarbyvägen is also a secondary road for dangerous goods when Södra Länken is closed. The speed limit is 30 km/h on the smaller roads and close to schools due to safety reasons, and 50 km/h on the area's main roads (Atkins, 2014). Hammarbyskogen lies within 500-700 meters from the metro station Hammarbyhöjden and the tram station Sickla kaj. The bus lines 194 and 904/905 are available from Hammarbyhöjden (Atkins, 2014). In the Regional Development Plan (2010), areas with access to public transport within 1200 meters are considered highly available.

There is a lack of parking lots in the area. Parking is free on the sides of the streets but they can be fully occupied sometimes. This causes a decrease in safety for pedestrians, who may have to walk out on the streets (Atkins, 2014)

7.6.2. Impacts during construction phase

During the construction phase there will be an increase in heavy traffic in the area. This can pose an increased risk of accidents, especially for children.

7.6.3. Consequences during operation phase

The new road that is planned through Hammarbyskogen between Finn Malmgrens väg and Heliosgatan will be more or less of a hinder for the species dispersal, depending on its size and the type of traffic. It is not yet decided if the road will be designed for car and bus traffic or only for bikes and pedestrians. The forest area will be less safe for children with the new road. There is a small risk that the road will be used for through traffic by cars going to or from Hammarby Sjöstad, which is unwanted by both the City and the residents of Hammarbyhöjden (Stadsbyggnadskontoret 2012). On the other hand, a connection between the areas Hammarbyhöjden and Hammarby Sjöstad would be positive for the goal of connecting city areas (Stockholm Comprehensive Plan, 2010).

Car traffic is expected to increase due to the development with about 500 cars per day on Finn Malmgrens väg, Sparrmansvägen and Olaus Magnus väg (Atkins 2014). This in turn could have impacts on noise levels, the air quality and the need for parking lots. Though, most of the additional travelling resulting from the project is predicted to consist of public transport, bicycle or pedestrian traffic, according to Atkins (2014). Counting 0,7 cars per household, which seems to be the average in other ongoing housing construction projects in Enskede-Årsta (Trafikutredningsbyrån, 2014), the number of cars in Hammarbyhöjden/Hammarbyskogen would increase by 665-805.

Parking areas on the ground level will be prohibited in the new housing area of Hammarbyskogen. New underground garages are planned to compensate for this. A larger parking area under Hammarby IP is planned and this is supposed to reduce the occurrence of cars parked on the sides of the streets in the residential area. In that case, a step would be taken toward the goal of making the streets more attractive for walking (Stadsledningskontoret, 2016). On the other hand, if the total car traffic increases too much, the need for parking lots may be even bigger than the garages can support.

The access to public transport for the residents in the new housing areas will be good. This has a good effect on the car-dependency and goes along with the goal of promoting public transportation (Stadsledningskontoret, 2016).

7.6.4. Mitigation measures for proposed plan

To reduce motor traffic on the new road, only bus traffic and emergency vehicles could be allowed, apart from bike- and pedestrian traffic. This would lead to less disturbance for humans and fauna and less risk for accidents, but still provide safety and accessibility for the different groups of people who can't walk far.

The overall increase in car traffic can be reduced by providing even better access to public transport, car pools and safe bicycle paths. This would also benefit the parking situation.

7.6.5. Consequences from zero alternative

The traffic can be expected to increase due to the surrounding housing developments, even if the projects Hammarbyskogen and Sjöstadshöjden are not implemented. The traffic closest to the forest can be expected to continue being as in the baseline though, and the absence of traffic in the forest will benefit both the recreational and ecological values. If the road through Hammarbyskogen is not built, there will be less of a connection between Hammarbyhöjden and Hammarby Sjöstad. There will still be a problem with the lack of parking areas if no garages are built.

7.6.6. Consequences from alternative A

The traffic is expected to increase in alternative A compared to the baseline, but the increase could be smaller compared to the proposed plan. Counting 0,7 cars per household, the number of cars in the area would increase by 420-455. There is no new road suggested in this alternative, which means that the area in and surrounding the forest will be kept relatively free from motor traffic. If the new road is not built, there would be less risk of through-traffic to and from Hammarby Sjöstad in the residential area of Hammarbyhöjden. Access to public transport is as good as in the proposed plan. The parking situation is expected to improve in the same way as in the proposed plan, with fewer cars parked on the streets and more underground garages.

7.7. Geology

7.7.1. Baseline

The lithology of Hammarbyskogen is mainly dominated by primary rocks, some post-glacial clay in the south corner and some sandy till in the northwestern part (figure 10). Hammarbyskogen is mainly represented by a thin groundcover and the soil depth varies between 0 and 2 meters, with an average depth of 1.3 meter. The soil consists mainly of artificial fill with variable composition. A natural soil is observed in the deeper layer and in the upper part of the wooded area. There was no soil contamination found except in the area of Indianparken, where investigations of soil contamination were indicated by the presence of Polycyclic Aromatic Hydrocarbon (PAH). The contaminated areas in Indianparken have been sanitized though (Ramböll, 2014).

Hammarbyskogen and Björkhagen are characterized by a topography variation between +20 and +62 meters. North of the area is represented by a fault scarp down to Hammarbyvägen with an elevation difference of 25 meters. While Hammarbyskogen shows a hilly terrain with an elevation difference between +39 and +46 meters (Ramböll, 2014).

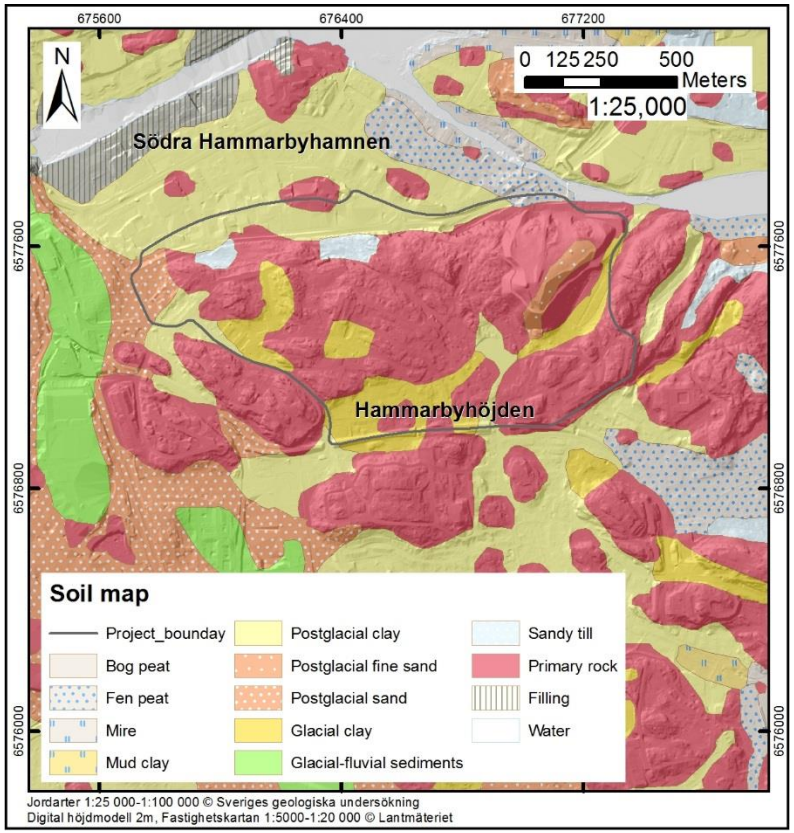


FIGURE 10. SOIL TYPES IN THE PROJECT AREA. HAMMARBYSKOGEN AND SJÖSTADSHÖJDEN IS MAINLY DOMINATED BY PRIMARY ROCKS WITH SOME POST GLACIAL CLAY AS WELL AS SOME SANDY TILL.

7.7.2. Impacts during construction phase

During the project construction phase, rock operation work will occur to create a suitable environment to build on. In order to create a flat surface, soil will be removed. According to the proposed plan a road will be developed in this area. The road will divide Hammarbyskogen and connect Hammarbyhöjden to Hammarby Sjöstad down by Hammarby Fabriksväg/ Hammarbyvägen. The topography difference has to be prepared for the road, since the road should not be steeper than 5 % to be able to achieve the demand of good accessibility. Therefore, large parts of the bedrock have to be blasted on the north side of Hammarbyskogen. Furthermore, soil and rock underneath the sports field must be removed to create space for the new garage under the sport field.

7.7.3. Consequences during operation phase

Based on Scalenghe and Marsan (2009) the interaction between soil-air is inhibited by the construction of a new proposed road and buildings. Consequently, the microorganisms within the soil are prevented to survive since they live in a closed system where the water and oxygen circulation is interrupted. Deforestation and elimination of vegetation cover leads to an increase in soil erosion (Piotrowska-Długosz and Charzyński, 2015).

7.7.4. Mitigation measures for proposed plan

A soil and rock management system should be implemented to dispose the generated waste material orderly. By using permeable pavement technology an interaction between soil-air can be preserved successfully. Since removing of vegetation cover is associated with soil loss, vegetation cover replacement should be kept at minimum.

7.7.5. Consequences from zero alternative

If the proposed plan would not be implemented, the consequences can be associated with no notable impact. First, the mining operation would not be undertaken and therefore mine waste would not be created. There would not be any changes in the topography and vegetation cover and this leads to preservation of the natural forest. In addition, no earthwork needs to be considered and therefore compensation of any fill or excavation can be avoided. Furthermore, tunneling or mining activity can be prevented as well. The new proposed road would not be developed which leads to minimizing of impacts on the natural forest. This also means there would not be any impact on the waterbody and land surface.

7.7.6. Consequences from alternative A

Alternative A leads to earth- and preparation works for the soil and the rock to create a flat building environment. In Hammarbyskogen blasting would take place to prepare the underground parking under the sports field and at the spots of the two existing park garages. The underground needs to be prepared for the road extension at the ending of Kalmgatan and for the new access road parallel to Hammarbyvägen. Soil and rock preparation would be reduced in comparison to the proposed plan, because of the reduced size of the project and the choice of location of the buildings situated mostly on residential areas.

7.8. Hydrology

7.8.1. Baseline

Hammarbyskogen is close to Årstaviken in the west (as part of lake Mälaren) and to Hammarbysjön and Sicklasjön in the north and east (as part of the Baltic Sea). These lakes are the natural recipients for Hammarbyskogen. We assume the natural runoff

is according to the surface runoff map (figure 11). According to topography map the sports field is lower than the northern part of Hammarbyskogen, therefore we assume there is a risk of flooding. Årstaviken shows a good water quality standard while Sicklasjön shows a moderate water quality (Stadsbyggnadskontoret, 2016).

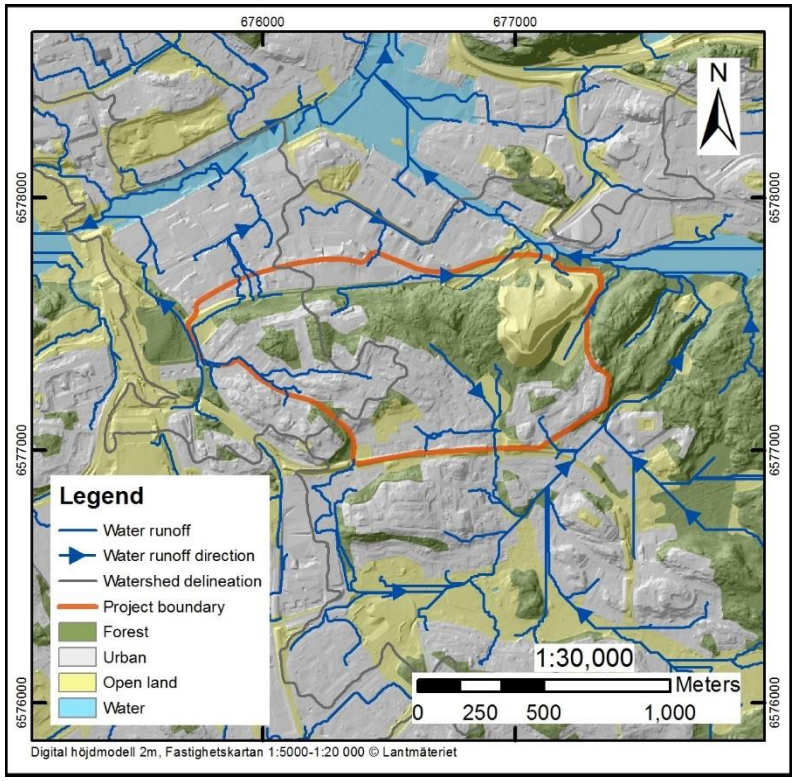


FIGURE 11. MAP SHOWING THE DIRECTION OF THE SURFACE WHICH SHOWS THE NATURAL RUNOFF IN THE PROJECT AREA INDICATING A RISK OF FLOODING.

In Hammarbyskogen there are a number of wetlands which today flows from Hammarbyhöjden and out through the steep parts towards Södra Hammarbyhamnen and Hammarby Sjöstad. During wintertime, these "outflows" form ice walls on the mountain side down to the existing roads (Rädda Hammarbyskogen, 2015). The wetlands play an important role and act as an equalizer during heavy rains.

Southeast of Hammarbyskogen lies a pipeline system where stormwater is mixed with the sewage water of Hammarbyhöjden and Björkhagen. According to Ramboll 2014 the water treatment system is old and tends to leak in some places.

The groundwater, used as drinking water by the Stockholm city residents, is located in the northwestern part of this area with a north - northwest direction of the water flow. The outflow leaves the catchment area towards Hammarbysjön and Årstaviken. The groundwater in the eastern part runs eastwards to the direction of the wetland areas in Nackareservatet and Sicklasjön (Ramboll 2014).

7.8.2. Impacts during construction phase

The implementation of the project could have an impact on the water treatment systems. The surface water flow will be different than in the current situation. Depending on how the constructions are carried out, the magnitude of the impacts is uncertain. The groundwater and surface water could potentially be polluted during the construction work from for example leaks from machinery.

7.8.3. Consequences during operation phase

As reported by The Stockholm Environment Program 2011-2015 the aim is to maintain the water quality in the lakes. Increasing infrastructure and housings is associated with larger

amount of nutrients, metals and harmful organic substances carried out within the storm water runoff into nearby lakes (Stadsbyggnadskontoret, 2016). Consequently, the water quality can be affected (Van Bohemen & Van De Laak, 2003). Less vegetation cover and an increase of compacted land, the natural drainage system can be disrupted. The implementation of roads, buildings and infrastructure may in times of heavy rain result in increased risk of flooding. In addition, decreasing wooded land to control the water flow velocity, the outflow velocity of the water in this area will increase. Another consequence is groundwater recharge due to the sealing of soil for infrastructural and housing purposes.

7.8.4. Mitigation measures for proposed plan

The topography in the northern part of Hammarbyskogen is inclining steep in the direction of Hammarbyvägen. The road system is planned to be expanded. During periods of precipitation, a system needs to be implemented to drain the storm water from the roads. To prevent high speed flows from steep topography along Hammarbyvägen where the project is planned to be implemented, it is important to make room for intercepting ditches where storm water can be smoothed out. Furthermore, the surface water flow needs to be dampened or a drainage system between the rock outcrop and the buildings is an advantage to be involved in this planning process. One proposed way of controlling the storm water is to build water stairs to decrease the flow. An open air system could also be considered.

Additionally, it is important to leave surfaces unsealed or partly sealed so the water can infiltrate in the ground. A further mitigation measure for both northern and southern sides would be houses with green roofs, that would increase the storm water uptake and reduce pollution as well.

In the southern part of Hammarbyskogen, the storm water collects in the low points of the topography and forms small ponds and wetlands. Rainwater should be routed in open systems leading to the existing wetlands. The wetlands contribute for the rainwater floods to be slowed down and cleaned. This is important in case there are many rain events to avoid flooding. The planned road runs through the forest and can act as a collective and guiding route for the storm water when extreme rainfalls occur. In order to manage the storm water better, it is important to preserve the forest as much as possible and create green beds with enhanced drainage between the houses in order to increase infiltration.

In the southern part of the Hammarbyskogen, it is easiest to use the existing low lying wetlands north of the bicycle path. Generally, it is recommended to leave as much area as possible unsealed to facilitate the infiltration of rainwater.

7.8.5. Consequences from zero alternative

The old infrastructure in Hammarbyhöjden, taking care of storm water runoff and sewage water, needs to be restored which is assumed to be done by the City. In some parts the system is leaking which could contaminate the groundwater with sewage water. Furthermore, the natural drainage system would be preserved as the natural vegetation cover will be untouched.

7.8.6. Consequences from alternative A

In alternative A, the developed area is smaller and with less sealed surfaces than in the proposed plan, and this result in a larger forest area being intact, so the water can continue to infiltrate. The wetlands which are important for storm water management are also preserved. If there is no improvement of the old pipeline system, leaching of sewage water could occur. This leads to groundwater and soil contamination.

7.9. Noise

7.9.1. Baseline

The equivalent noise level among the houses in the area lies between 40 and 60 dBA. On the main streets, such as Finn Malmgrens väg and Olaus Magnus väg, the equivalent level is up to 75 dBA (figure 12). On Hammarbyvägen it is above 75 dBA. Hammarbyskogen has a low noise level, mostly between 40 and 45 dBA, which makes it a calm area suitable for recreation.

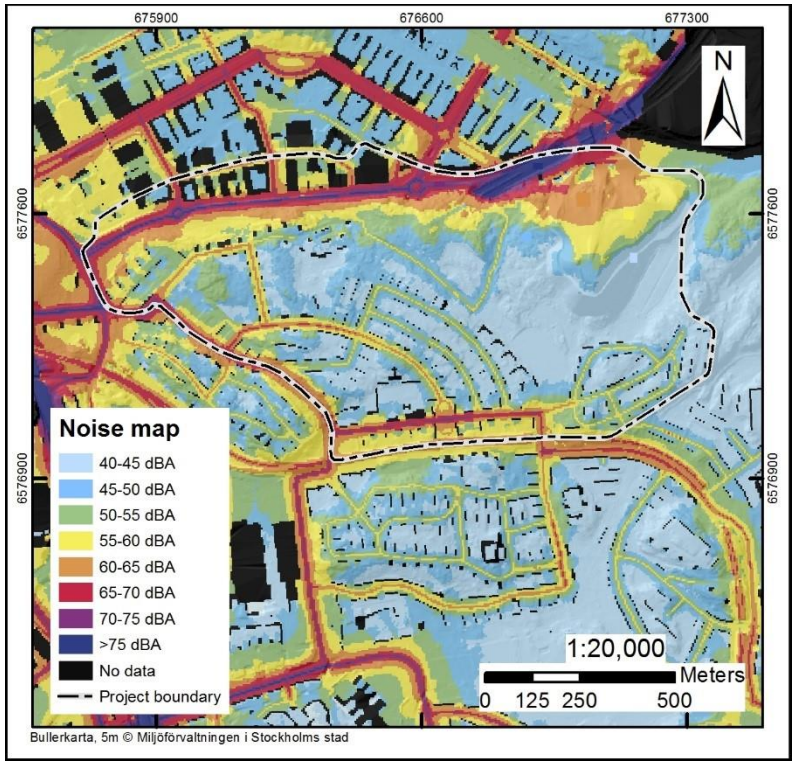


FIGURE 12. NOISE MAP FOR THE PROJECT AREA INDICATING THAT NOISE LEVELS AMONG HOUSES LIES BETWEEN 40 AND 60 DBA. HIGHER LEVELS OF NOISE HAVE BEEN REACHED ON HAMMARBYVÄGEN, FINN MALMGRENS VÄG AND OLAUS MAGNUS VÄG.

According to a noise level investigation made in 2006, the neighborhood in Hammarbyhöjden is relatively quiet (Hallin et al., 2006). Though, a few of the facades of the existing houses have an equivalent noise level higher than 55 dBA (Hallin et al., 2006), which is the threshold value for house facades in Sweden (Förordning 2015:216 om trafikbuller vid bostadsbyggnader). The threshold value of 55 dBA is allowed to be exceeded if the apartments have one quieter side, where the equivalent noise level is below 55 dBA by the facade (Förordning 2015:216).

The narrow strip of green area where Sjöstadshöjden is planned, has an equivalent noise level of 55-70 dBA, because of the proximity to the heavily trafficked Hammarbyvägen.

7.9.2. Impacts during construction phase

The construction will create high levels of noise from machines, traffic and possibly blasting. This will mainly affect the residents in Hammarbyhöjden and Hammarby Sjöstad negatively, as well as the animals living in the forest area.

7.9.3. Consequences during operation phase

The new houses of the project Hammarbyskogen will be built in places where the noise level today is below 50 dBA, which means the noise levels among the new houses are expected to be below the maximum levels for residential areas. Increases in car traffic would lead to an acceptable increase in noise levels. Although, the new houses in Sjöstadshöjden are planned in an area where the noise level today is 55-70 dBA, i.e. over the threshold value of 55 dBA. This means that without mitigation measures, the project Sjöstadshöjden would not follow current regulations.

7.9.4. Mitigation measures for proposed plan

Only building during daytime reduces the disturbance from noise for the residents. Blasting should also be avoided to as large extent as possible. Trafikverket (2004) also suggests keeping the speed limit low, which would keep noise levels down on the new road.

A covering of Hammarbyvägen is suggested in the development program. It can be seen as a mitigation measure for the noise levels in the proposed development area for Sjöstadshöjden. Another option in the program is to develop Hammarbyvägen into a city street, which would reduce the heavy traffic and the speed limits (Rosendahl, personal communication 2016-12-12). It is uncertain if the noise levels would be reduced enough through these measures only. As a secondary option, a mitigating measure could be to ensure that at least one side of each apartment will have a noise level below 55 dBA by the facade, which is an accepted exception in the noise regulation (Förordning 2015:216).

7.9.5. Consequences from zero alternative

The noise levels are basically expected to remain the same as in the baseline if the projects are not realized, although a smaller increase of noise can be expected among the main roads due to increased traffic from other developments outside the area.

7.9.6. Consequences from alternative A

The alternative A suggests building apartments in an area along Hammarbyvägen where the noise levels (55-70 dBA) today are exceeding the threshold value. Noise protection walls are a suggested mitigation for this problem, but there are indications that because of the proposed height of the buildings, noise protection walls would not be enough since the noise travels above protection walls and reaches the higher storeys of the buildings (Trafikverket, 2004). Further investigations will be needed to make sure that the noise levels can be kept below 55 dBA by the facades of the buildings, on at least one side of each apartment.

The other locations where apartments are suggested in this alternative have lower noise levels, all below 55 dBA. Since no new road is suggested, the forest could be kept a calm and quiet place.

7.10. Air and climate

7.10.1. Baseline

Particles (PM10) and nitrogen dioxide (NO_2) are the air pollutants that have the highest levels in Stockholm today in comparison with environmental quality standards for the protection of human health (SLB-Analys, 2016). In this EIA, these are the pollutants included in our boundaries. An assumption has been made, that the effect on global climate will be minimal due to the small scale and the type of project. Therefore, focus will be on the local climate of the project area and its closest surroundings.

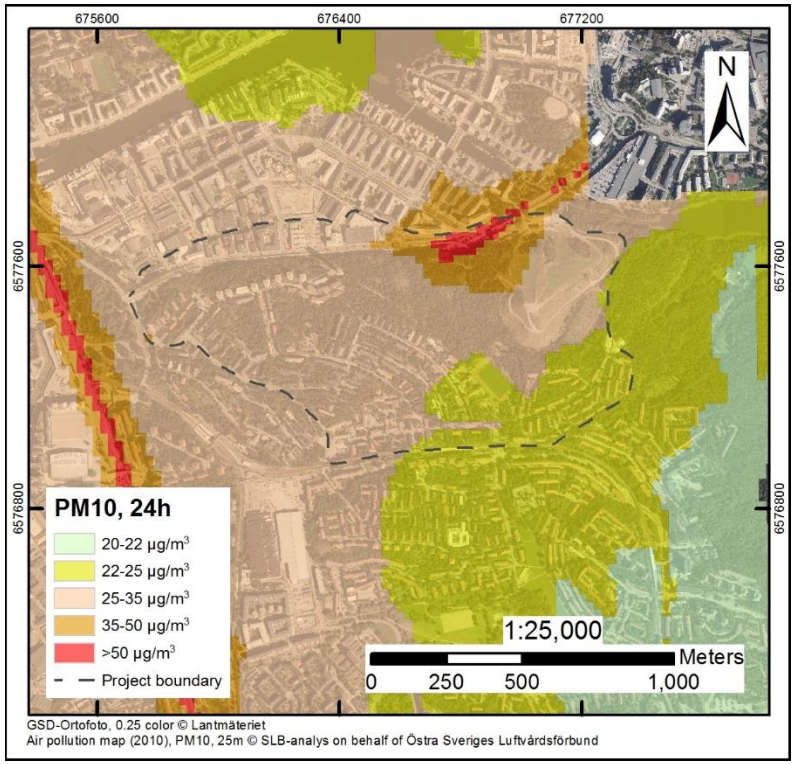


FIGURE 13. LEVELS OF PM10 IN THE PROJECT AREA. ALONG HAMMARBYVÄGEN THE LEVELS OF PM10 ARE CLOSE TO OR OVER THE SWEDISH AIR QUALITY ORDINANCE (SFS 2010:477).

The air quality in the southeast part of Hammarbyskogen is generally supposed to be better since the traffic volume is much lower compared to parts along Hammarbyvägen in the north (Atkins, 2014). Currently, high levels close to or over the Swedish Air Quality Ordinance (SFS 2010:477) of PM10 (figure 13) and NO_2 (figure 14) have been measured along Hammarbyvägen. These pollutants have a vast impact on both sides of Hammarbyvägen as well as for the northward parts of Hammarbyskogen.

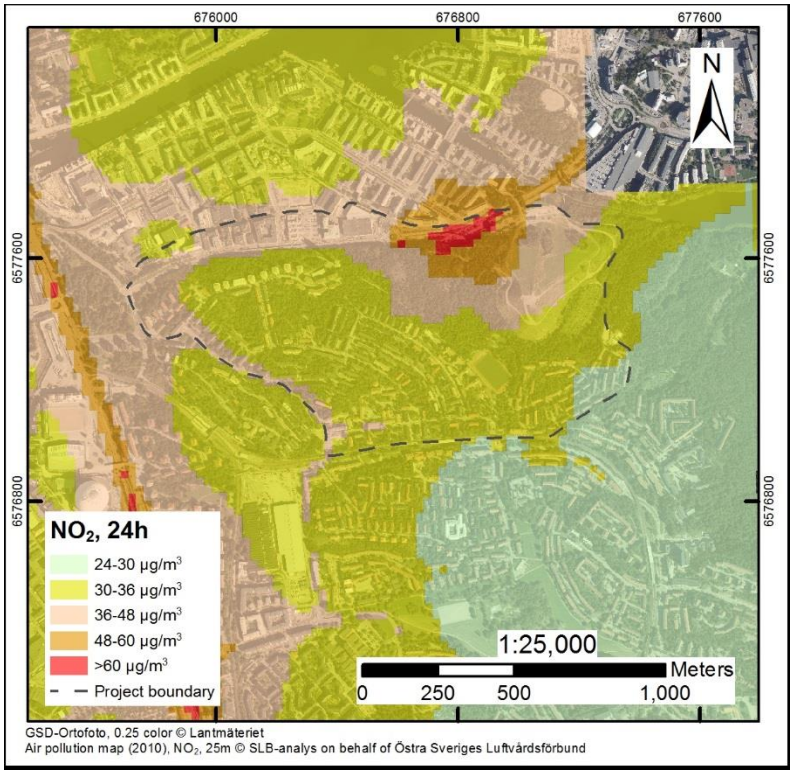


FIGURE 14. LEVELS OF NO_2 IN THE PROJECT AREA. ALONG HAMMARBYVÄGEN THE LEVELS OF NO_2 ARE CLOSE TO OR OVER THE SWEDISH AIR QUALITY ORDINANCE (SFS 2010:477).

Hammarbyskogen acts as an important air cleaner. Based on Timilsina et al., (2014) it can be assumed that Hammarbyskogen is a carbon dioxide sink due to photosynthesis. Furthermore, with an expected warmer climate in the future, Hammarbyskogen can also be expected to contribute to a natural cooling effect for the local climate systems (Taha, 1997). It is known, dark surface concrete and asphalt absorb significantly more solar radiation and release heat (the so-called urban heat island effect). According to Nature Conservancy USA

(2016), a natural compensation of the heat accumulation is provided by trees. For example, shade from a tree depends upon crown shape and density, where a broad shade and high density is being best. This will inhibit the solar radiation to heat the surface. Furthermore, trees cool the local microclimate through evapotranspiration.

7.10.2. Impacts during construction phase

Heavy traffic would be relatively extensive due to activities such as blasting and excavation. This will lead to increased levels of NO2 and PM10 as well as larger dust particles. Particularly the construction of the planned underground garage under the sports field would cause many heavy transports through the existing residential areas of Hammarbyhöjden resulting in extensive air pollution. The removal of the surface layers of the soil as well as some blasting will also generate dust particles. The dust particles will pollute the atmosphere and if inhaled, could lead to related health hazards for workers and the surrounding people resident at close proximity to the sites. Furthermore, the dust particles will cause dirt on the surrounding buildings.

7.10.3. Consequences during operation phase

According to Atkins (2014), the traffic volume is expected to increase even without the proposed plan. With 1 000 new apartments being built, a further increase in the local traffic volume is to be expected with another 500-700 cars (Trafikutredningsbyrån, 2014).

As seen in figure 13 and 14, strong impacts in the vast spread of NO_2 and PM10 into these areas have even today significant impacts. With the expected exploitation this impact would be even stronger (Bottalico et. al., 2015; Beckett et al., 1998). Without covering, tunneling or making Hammarbyvägen to a smaller city street, a non-sustainable air situation could be expected. A larger traffic volume in combination with lesser extent of forest areas could have negative consequences and could strongly impact the air quality (Taha, 1997; Donner et. al., 2015). The loss of forest areas could also have an additional negative impact on the surrounding areas such as Södra Hammarbyhamnen and Hammarby Sjöstad. These are areas consisting almost exclusively of hard surfaces and are acting as a large heat island. As with other comparable areas in works by Donner et. al., 2015, It can be assumed that Hammarbyskogen assists in cooling the local climate and helps to even temperatures during the warm season in these areas. Furthermore, the planned road cutting through the forest will put even more pressure on the forest as this area's main service provides for Ecosystem Services.

7.10.4. Mitigation measures for proposed plan

However, if the citizens in the new residential areas would use the good public transportation access of the nearby subway, instead of going by car, this would have positive effects on both air and climate. With a regional or global perspective, the increase in citizens in this urban area would be better than an increase in areas without public transportation access. The development of better bike- and pedestrian roads could further decrease the need for private cars.

An over-decking of Hammarbyvägen which is suggested in the development program, can be seen as a mitigation measure also for the air pollution levels in the proposed development area of Sjöstadshöjden. Another option in the proposed plan is to develop Hammarbyvägen into a city street.

To keep the forest as coherent as possible it is vital to keep as much of the Ecosystem Services as possible intact. However, the

level of Ecosystem Services delivered is unclear and should be investigated further in the planning.

7.10.5. Consequences from zero alternative

The measured values in figure 13 and 14 are assumed to remain high in terms of NO^2 and PM10. Prolonged exposure to small particles found in traffic fumes can be more deadly than previously thought. This also applies to levels below the EU limits for air quality according to the same source (UNECE,2016).

In a timeframe as far away as 2040, not many alternations in the tree fauna is considered to have an effect that will change the Ecosystem services provided by the forest due to the slow growth of trees. For an even longer time perspective beyond 2040, as the trees grow older and take more space, they will be seen as exceedingly valuable in many aspects, for example as old giants and with even greater ecological value. In this phase they could even be crowding out younger tree generations and this could then change the type and extent of the Ecosystem Services. This scenario would probably happen only if a forest caring plan is being implemented promoting this type of scenario.

7.10.6. Consequences from alternative A

As seen in earlier sections we can assume the traffic volume will increase. This will have a negative impact in terms of air pollution and create an even stronger reliance on the Ecosystem Services offered by Hammarbyskogen. With an expected rise in number of cars in the area, in combination with no covering, tunneling or transforming Hammarbyvägen into a smaller city street, it can be expected to be a non-sustainable air quality situation that would not be accepted. It could even lead to exceeding of the national quality standards for air pollution.

As a larger part of Hammarbyskogen will remain with this alternative compared to the proposed plan, it can be assumed that Hammarbyskogen will continue to be considered a fundamental source of many of the Ecosystem Services already mentioned. Alternative A offers a coherent forest with a minimum of scattered forest patches. As mitigation measures, the same measures as mentioned in 6.10.4 are recommended.

8. Results

In the matrix below (table 2), all the impacts considered in this EIA can be found. The description for how the evaluation was made is presented in chapter 3.4.

8.1. Impact assessment matrix

TABLE 2. IMPACT ASSESSMENT MATRIX. ALL THE ASPECTS INVESTIGATED IN THIS EIA ARE LISTED IN THE LEFT COLUMN. THE IMPACTS OF EACH ASPECT ARE LISTED IN THE FOLLOWING COLUMNS, FOR THE PROPOSED PLAN, ZERO ALTERNATIVE AND ALTERNATIVE A RESPECTIVELY. RED CELLS MEAN THAT THE ALTERNATIVE HAS MAJOR NEGATIVE IMPACTS ON THE ASPECT. LIGHT RED COLOR MEANS MINOR NEGATIVE IMPACT, YELLOW MEANS NO IMPACT, LIGHT GREEN MEANS MINOR POSITIVE IMPACTS AND GREEN MEANS MAJOR POSITIVE IMPACT. SOME CELLS ARE DIVIDED IN TO TWO COLORS, WHICH MEANS THAT THE ALTERNATIVE HAVE TWO DIFFERENT IMPACTS ON THE ASPECT (FOR EXAMPLE TRAFFIC, SOCIAL SERVICES AND LOCAL ECONOMY).

Aspects	Proposed plan	Zero alternative	Alternative A
Vegetation	**Major negative impact** The development would cause forest fragmentation and constitute a barrier for species dispersal. A loss of older trees would cause a decline in fungi species populations that are classified as near threatened. Areas of valuable wetlands may be lost or negatively affected. The program would counteract the regional goals *A Rich Diversity of Plant and Animal Life*, and *Thriving wetlands.* Furthermore, hard dead wood and dead trees, which are indicators for the environmental goal *Sustainable forest*, are expected to decrease.	**Minor positive impact** No development in Hammarbyskogen and Sjöstadshöjden would mean no notable impact on the vegetation. The species diversity is likely to be preserved. Over time old trees will age and increase in value. Densification of Hammarbyhöjden and Björkhagen might cause an increased pressure on the forest area from recreational activities.	**Major negative impact** The development will cause loss of a large areas of vegetation and decrease the diversity of flora. The development will most likely have a negative effect on valuable areas of dead wood and old trees. The connection between Nackareservatet and Årstaskogen will weaken due to the development in Sjöstadshöjden. Therefore, the development would counteract the regional goal *A Rich Diversity of Plant and Animal Life* as well as the environmental goal *Sustainable forest*.

Aspects	Proposed plan	Zero alternative	Alternative A
Fauna	**Major negative impact** The development would limit the dispersal ability and lead to habitat fragmentation. This will in turn result in a reduction of biodiversity. Therefore the project will counteract the regional goal *A Rich Diversity of Plant and Animal Life*.	**Minor positive impact** No development in Hammarbyskogen and Sjöstadshöjden would mean no notable impact on the fauna living there.	**Major negative impact** Alternative A might also mean less biodiversity. This would be caused by the increased disturbance of human activities and a reduced dispersal ability when the green corridor is being reduced. This counteract the regional goal *A Rich Diversity of Plant and Animal Life*, even if the negative impact is not believed to be as big as in the proposed plan.
Cultural heritage values	**No impact** The planned development would be located outside valuable areas.	**No impact** No influence on today's cultural heritage values.	**Minor negative impact** The proposed buildings' height could have a negative effect on cultural heritage values in east Hammarbyhöjden.
Green areas and recreation	**Major negative impact** One of the goals of the Stockholm Environment Program is to meet the residents' recreational needs. The developments in Hammarbyskogen will lead to significantly less green areas and silent areas. Therefore, the program will strongly counteract with this goal.	**No impact** No development in Hammarbyskogen would mean no notable impact on green areas and recreation.	**Minor negative impact** One of the goals of the Stockholm Environment Program is to meet the residents' recreational needs. The alternative development will lead to slightly less green areas. Therefore, the alternative will counteract with this goal, but not hinder it.

Aspect	Proposed plan	Zero alternative	Alternative A
Social services and local economy	**Major positive impact** The proposed school and the full size sports facility would provide both kids in the area and Hammarby Sjöstad with better access. An increase in social services like shops, cafes etc. would be positive for the mainly residential area.	**Major negative impact** Neither of the regional development goals to *increase the density of the built environment,* or the City's goals to *strengthen central Stockholm* with a better access between Hammarby Sjöstad and Gullmarsplan would be attained. **Minor negative impact** The City's population prognosis shows an increased need for schools in the area, which would not be met.	**Major positive impact** An increase in social services like shops, cafes etc. would be positive for the mainly residential area.
Traffic	**Minor negative impact** Car traffic in the area can be expected to increase through the development, especially during the construction phase. This can increase the risk of accidents and decrease the attractivity of walking and biking. This counteracts with the goal "A modern transportation system and sustainable travelling" in Comprehensive Plan for Stockholm. **Minor positive impact** The parking situation could be improved through the development. The risk of accidents as well as obstacles for pedestrians and cyclists, would thereby be decreased. Access to public transport for the new residents will be good. This would support the goal "A modern transportation system and sustainable travelling" in Comprehensive Plan for Stockholm.	**No impact** A slight increase in car traffic can be expected even without the proposed development, but may not have a notable impact.	**Minor negative impact** Car traffic in the area can be expected to increase, especially during the construction phase. This can increase the risk of accidents and decrease the attractivity of walking and biking, although not in the forest as opposed to the proposed plan. This counteracts with the goal "A modern transportation system and sustainable travelling" in the Comprehensive Plan for Stockholm. **Minor positive impact** The parking situation can be improved by the alternative development. The risk of accidents as well as obstacles for pedestrians and cyclists, may decrease. Access to public transport for the new residents will be good. This supports the goal "A modern transportation system and sustainable travelling" in Comprehensive Plan for Stockholm.

Aspect	Proposed plan	Zero alternative	Alternative A
Geology	**Minor negative impact** The implementation will cause construction and demolition waste. Some parts of the area will be covered by roads and housings and this in turn could inhibit the interaction between soil-water-air systems.	**No impact** Without the development, there will be no impact on the geology.	**Minor negative impact** The construction would still produce waste and blasting, but the dimension is smaller, so impacts are smaller than the in the proposed plan.
Hydrology	**Minor negative impact** The implementation will cause changes in the natural drainage system and increases surface water runoff. This could in turn leads to flooding in this area due to less infiltration. Furthermore, the velocity of the storm water overflow will increase since there is no vegetation cover.	**No impact** No development is assumed to lead to no notable impact.	**No impact** Alternative A leads to less changes of the system. This will result in a smaller change of the surface water runoff. There is no impact caused by leakage processes in some parts of the sewage system since they are improved. The impacts of alternative A is therefore smaller compared to the proposed plan.
Noise	**Minor negative impact** Noise levels will be slightly increased due to increased traffic. The forest will no longer be a calm and quiet space. Some of the houses are planned in an area where noise levels exceed the threshold value for house facades today. This is expected to be mitigated, but it is uncertain if the goals would be reached.	**No impact** No development in Hammarbyskogen would lead to no notable impacts on noise levels.	**No impact** Noise levels will be slightly increased in Eastern Hammarbyskogen due to increased traffic, but won't exceed noise limits. **Minor negative impact** The houses in Sjöstadshöjden are planned where noise levels exceed the threshold value for house facades today. Mitigation measures must be investigated.

Aspect	Proposed plan	Zero alternative	Alternative A
Air and climate	**Major negative impact** The calculated 1000 apartments will increase the traffic with 5-10%. This will impair the air quality. The Swedish Environmental quality standards for of NO2 and PM10 set up in SFS 2010:477 will probably be exceeded and the National Environmental Objectives for Clean Air will not be fulfilled. It is assumed that a fragmentation and or clearance of Hammarbyskogen will have a negative effect on the existing Ecosystem Services. such as air cleaning and cooling measures for the local climate.	**Minor negative impact** Environmental quality standards for of NO_2 and PM10 set up in SFS 2010:477 are close to or even exceeded and the National Environmental Objectives for Clean Air is not fulfilled. Hammarbyskogen continues to act as functional base for all the Ecosystem Services.	**Minor negative impact** Increased traffic volume will impair the air quality. Environmental quality standards for of NO_2 and PM10 set up in SFS 2010:477 are close to or even exceeded and the National Environmental Objectives for Clean Air will not be fulfilled. As Hammarbyskogen remains almost intact, it is assumed the existing Ecosystem Services continues to be delivered. It is an uncertainty to what extent the Ecosystem Services will have as a mitigation measure.

9. Discussion

Based on the investigations made by consultants, the City decided that there was no need to carry out an EIA (Samrådshandling, 2014). As the building pressure rises, EIA's could pose problems for planning proposals. The City has done a number of investigations (Area-, and Day-water Analysis; Sun-, and Traffic Studies; Cultural Heritage and Child Consequence Analyses; as well as an Green Strategies analysis). However, they refrained from doing several investigations (i.e. wetland investigation) or inventories of animals and trees (i.e. newts) and therefore risk missing out on species that are protected by law or are of high value. For example, the presence of the Great Crested Newt ("Större vattensalamander"). have resulted in other projects being cancelled.

During the interview with the Swedish Society for Nature Conservation (Tranberg, personal communication, 2016-12-07) we received copies from a number of older documents concerning the values of the forest area in Hammarbyskogen. In these documents, it is stated that the area was supposed to be protected for future recreational use. Tranberg pointed out that these older decisions to preserve the forest have been remade in the newer Comprehensive Plans and Regional Development Goals for Stockholm (RUFS). The focus has shifted from conservation of green areas toward building apartments in a time of housing scarcity (Miljöförvaltningen, 2005). This would suggest that the exploitation of Hammarbyskogen would have been politically impossible only a few years back. If we extrapolate into the future, the exploitation of Hammarbyskogen may become impossible again if the need for residential areas, schools and preschools would decrease.

In the following sections, major negative impacts (9.1) as well as other impacts (9.2) from the proposed plan and alternative A are discussed. Apart from that, the proposed alternative and a comparison of the proposed plan and alternatives (9.3) as well the impact assessment matrix (9.4) are analyzed.

9.1. Major negative impacts from proposed plan

The most valuable environmental aspects to preserve are vegetation, fauna and recreation. In the current situation, the forest consists of a mosaic of different vegetation types and habitats, such as wetlands, wooded bog areas, dead wood, hollow trees, older populations of oaks and pines, boulder slopes and rock outcrops. This mosaic of vegetation types allows a range of potential habitat for different species, which favors a rich biodiversity. Valuable species such as White Speck and Oak Fungus, which are red listed and classified as near threatened are present in the forest. The forest is dominated by older pine trees with areas of old oak trees. When considering the exploitation of Hammarbyskogen and Sjöstadshöjden it is important to consider how the ecological values will change over time. For example, the old oak and pine trees in Hammarbyskogen have a high ecological value, which will continue to increase as years go by. At the same time, areas with old trees are becoming rarer, which further increases their value.

The only connection for species dispersal between Hammarbyskogen and Årstaskogen is through the green corridor in the western end of the area. Today the corridor is already narrow and the dispersal connection across this corridor is quite limited. This could be an argument for the development of buildings in this corridor since it is of very little use or to no use at all for animals today. However, we believe the contrary, that it is especially important to maintain the

corridor as far as possible, since the opportunity for animals to other passages are even more limited. Furthermore, the development in the forest would mean a loss and fragmentation of habitats. Since diversity is linked to the size of an area, a reduction of biodiversity is expected (Ekologigruppen, 2015). To minimize the negative effects that may come from an isolated forest area, such as inbreeding and biodiversity loss, it is of high importance to strengthen the connection at its weakest points.

Smooth Newts have been found in Hammarbyskogen, which means that the habitat could be suitable for the Great Crested Newt. Moreover, the Great Crested Newt has been found in nearby areas, such as Skogskyrkogården in 2010 and in the Globe area before the development of the sports arena in the 1960s. The Great Crested Newt is protected by the Species Protection Ordinance with the term S B - N (Artskyddsförordningen 2007:845). This means that the species has such a big union interest that special conservation areas need to be designated, and that the species requires careful protection. If the species would be found in Hammarbyskogen, this would theoretically mean that the project could be stopped (Zachariassen, written communication, 2016-12-09). Translocation of Newts has been used as a strategy to be able to exploit areas containing the species. However, research has shown that translocation can harm the populations and is therefore not to be prefered (Gustafsson et al., 2016). Therefore, we believe that a thorough inventory of amphibians is needed to determine if the Great Crested Newt exists in Hammarbyskogen. Inventories are neither costly nor time consuming in comparison to what has been spent on a project of this size. Therefore, it would be interesting to know why there were no inventories done from the beginning.

An EIA case that went to the Supreme Administrative Court (UNECE, 2012), the developer and the County Administrative Board did not consider the existence of the Great Crested Newt. There was no EIA or proper inventory made. A number of citizens appeared at the Environmental Supreme Court. The court judged that the project did require an EIA and stopped the detailed development plan (UNECE, 2012).

The forest is frequently used, both for recreational and educational purposes. Recreational values are considered to be the *feeling of nature*, *nature experience*, *walks*, *picnics* and *peacefulness,* which are indicating quality (Ekologigruppen, 2015). Exploitation of this area would mean that less nature and fewer recreational values remains. According to the Stockholm's Environmental Program (Stadsledningskontoret, 2016), it is recommended that the distance to the nearest green area is not more than 200 meters. This recommendation cannot be fulfilled in regards to the proposed plan. The increased distance, combined with the loss of recreational values could potentially mean a decrease in health of the residents who use the forest daily, especially elderly and children (Lindahl, personal communication 2016-11-30). Additionally, a larger number of residents in the area would probably result in the forest being used to a higher extent compared to today. This could in turn lead to a greater wear of the nature that is left, leading to a loss of the aesthetic values.

Natural forest with older trees can be assumed to have a higher natural value than park areas where old trees are replaced with planted young trees. In the proposed plan the suggestion is to compensate the forest loss with parks. In the future, this could lead to even further development in Hammarbyskogen, since it could be argued that a park is not valuable enough to preserve compared to the need for housing.

Major negative impacts were also found on air quality as well as the local climate. The results show that the potential future residents of Sjöstadshöjden would be exposed to relatively high levels of traffic-related air pollution. Residents in this area would have a larger exposure to respiring pollutants (PM10 and NO_2) compared to residents in a less congested area (Bottalico et. al., 2015; Beckett et al., 1998). When considering the areas Södra Hammarbyhamnen and Hammarby Sjöstad, that act as an coherent heat island, Hammarbyskogen should be viewed as a valuable resource for both air cleaning and air cooling (Taha, 1997; Donner et. al., 2015).

The United Nations predicts that more than two-thirds of the world's population will live in cities by 2050, increasing the number of people exposed to dangerous air conditions, especially if temperatures and PM levels continue to climb at their current rate (UN Migration Agency, 2015). The City's strategy is to build a dense city close to public transport and expand the pedestrian and bicycle connections. This could result in a lower rate of car use, which would lead to better air quality. A literature review by Nature Conservancy (2016) showed that trees provide meaningful but locally concentrated reductions in PM10 and NO_2. Trees also prevent large fluctuations in temperature. The majority of regulatory services provided by trees are generally within 300 meters from the forest (The Nature Conservancy US, 2016). Therefore, Hammarbyskogen is providing important ecosystem services to the nearby areas that are not in reach of the services provided by Nackareservatet.

According to the precautionary principle (see Swedish Environmental Code 1998:808, chapter 2, section 3), the developer must take measures to prevent damage or harm to the environment. These precautions should be made as soon as the activity is likely to harm or detriment human health or the environment. In the continued program process, it is important to take this principle into account, for example by implementing inventories as well as to propose and carry out mitigating measures.

9.2. Other impacts from proposed plan and alternative A

The remaining aspects investigated in this EIA are found to have none or minor impacts, but are altogether important to take into consideration.

New residential buildings would not have any impact on existing buildings, unless new buildings from either the proposed plan or from the alternative A are placed in a way that decreases the cultural heritage values. In the detailed development process, building design, location and height need to be considered.

When developing new residential areas, it is important that the City Planning Office consider the social structure of the neighborhood. It is normal that newly built apartments, especially this close to the city center, have high rents or market values. This result in financially well off tenants and buyers. If the City strives for a mix of new residents, affordable housing needs to be built. Young people leaving home, students and elderly's need to be considered. When the City is deciding on the detailed development plan in a negotiation process with construction- and property companies, they should use their leverage to make sure that the City's social needs are met. They also need to have apartments reserved for the Social Services ("socialtjänsten") and for immigrants.

The traffic situation will both benefit from and be disadvantaged by the proposed development. An important goal for the City's traffic situation is to promote walking, biking and public transportation. This goal is supported in several ways, for example by the proximity to public transport and the development of bicycle paths. A general increase in car traffic in the area and especially the planned new road, counteracts with the goal. The new road provides a new connection between Hammarbyhöjden and Hammarby Sjöstad which can be seen as positive, considering the City's goal of connecting city areas, but negative when considering the risk of through-traffic through the forest.

The City Planning Office needs to ensure that the noise levels can be kept at an acceptable level, which would not be the case if housing in Sjöstadshöjden would be developed today without any mitigating measures. Concerning the noise levels, a covering of Hammarbyvägen might be a required condition for building apartments in the area of Sjöstadshöjden, both for the proposed plan and for alternative A.

The proposed plan and alternative A will have some impacts on geology and hydrology caused mainly by excavation, blasting and sealing activities. However, there are precautionary measures for soil and water management to either decrease or avoid the expected impacts. For that reason, the impacts on hydrology and geology are considered as not being notable and are therefore not discussed further.

9.3. Proposed alternative (Alternative A)

According to the proposed plan a new road is planned (Stadsbyggnadskontoret, 2016) to connect Hammarbyhöjden and Hammarby Sjöstad. To prevent fragmentation, noise and air pollution caused by traffic and also to not disturb the interaction between the soil-water-air systems, this road is left out in alternative A.

Compared to the proposed plan, alternative A preserves 5 more hectares of forest. Though, any development in the area would involve risks for the flora and fauna since it consists of construction works, green area loss and also result in an increased population in Hammarbyhöjden. A positive aspect from alternative A is that the development includes the social benefits of new schools, apartments and shops without interfering too much with the environment.

The buildings are higher in alternative A than in the proposed plan. More apartments per building would keep the land-use to a minimum. In turn, the high buildings could be conflicting with the cultural heritage aspects. The purpose of designing the houses with wooden house facades in alternative A was to achieve a better atmosphere with the natural surroundings.

9.4. Analysis of impact assessment matrix

For some aspects such as vegetation and fauna, the magnitude of impacts is equivalent when comparing the proposed plan with alternative A. The impacts from alternative A are generally smaller compared to the proposed plan. However, this is not seen in the five step scale of the impact assessment matrix. To see such differences, a modification of the matrix's scale from a five- to seven or nine step scale would have been needed. However, in this project, with the time frame given, it was not possible to go into such detail. As a visual tool, a five-step matrix was found to give a good general overview and quickly show which impacts are positive or negative.

10. Conclusion

The Environmental Impact Assessment presented in this document shows that an exploitation of Hammarbyskogen and Sjöstadshöjden would cause major negative impacts on vegetation, fauna, recreation and air quality. Alternative A that is proposed in this report would most likely mean less negative impacts on these environmental aspects, but since alternative A still leads to negative consequences, including some major adverse impacts, no development in either area are to be preferred. The proposed plan and alternative A would lead to a reduction of the housing shortage in Stockholm. However, our assessment shows that there are multiple negative impacts that this development would cause on Hammarbyskogen and Sjöstadshöjden. Therefore, we recommend that an exploitation of Hammarbyskogen and Sjöstadshöjden should be avoided.

Further investigations and inventories of the area are needed, since Hammarbyskogen might constitute habitats for valuable species. For example, we believe that there is a chance that the protected Great Crested Newt could exists in wetland areas of Hammarbyskogen.

When summarizing the negative consequences of the impacts as well as the chance of valuable species existing in the areas we come to the recommend that an EIA for Hammarbyskogen and Sjöstadshöjden should be executed.

11. References

10.1 Laws and regulations

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Appendix A. Interview questions

Erik Zachariassen (Ekologigruppen)

1. What risks and benefits do you see with developing a forest area into a park. (Eg. Loss of diversity)?
2. If Hammarbyskogen and Sjöstadshöjden is developed the "dispersal-connection" (spridningssamband) between Nackareservatet and Årstaskogen seem to have to take a new route and will have to cross three roads (Kalmgatan, Strahlenbergsgatan + the new developed road), this must weaken the link and potentially be harmful for the diversity in Årstskogen. What are your thoughts about this?
3. Will you be able to use the Swedish Standard "Naturvärdesinventering" in your work with Hammarby forest?
4. Who chooses the scale of the investigated effects? Do the City/developer have opinions about it?
5. What would do you think are the most important impacts and why?
6. How did you value if the impacts were relevant or not?
7. When the Phellinus pini (Tallticka) is so valuable, why do they still consider to build in that area? Can it be stopped?
8. Have you considered the effects of the school and the schoolyard on the "dispersal-connection" (spridningssamband)? The corridor left between the schoolyard and Hammarbybacken in the development plan seems very narrow.
9. Will you be involved in the coming Detail Plan? What would you consider to be important to look for in a natural value inventory and what scale would you use?

10. Do you agree with the City about the decisions not to do an EIA? Is it often the case?

Olle Siltberg (Rädda Hammarbyskogen)

1. Is there any part of the plan that you think is good, and would like to keep?
2. Since there is a shortage of housings in Stockholm, more flats are required. Where do you think that this project should be moved instead?
3. Have you any suggestions for any alternatives, scale, design, location?
4. How much have you been able to change from the original plan (number of flats for example) during the process with the City?
5. Do you know the status of the work with the coming detail plan?
6. Do you have a good communication with the City planners?
7. Have you made a count of the Tallticka and older oaks and pines in the whole Hammarby forest?
8. Do you have an inventory list of vulnerable species?
9. Do you think Hammarbyskogen has any values that Nackareservatet doesn't have?
10. Do you think there will be enough space for recreation left if they leave e.g. half of the forest?

Anders Tranberg (Swedish Society for Nature Conservation)

1. Do you agree with the City about the decisions not to do an EIA? Is it often the case?
2. Who chooses the scale of the investigated effects? Do the City/developer have opinions about it?
3. If Hammarbyskogen and Sjöstadshöjden is developed the "dispersal-connection" (spridningssamband/ekologiskt samband) between Nackareservatet and Årstaskogen seem to have to take a new route and will have to cross the roads (Kalmgatan, Strahlenbergsgatan + the new developed road), this must weaken the link and potentially be harmful for the diversity in Årstskogen. What are your thoughts about this?
4. Have you considered the effects of the school and the schoolyard on the "dispersal-connection" (spridningssamband/ekologiskt samband)? The corridor left between the schoolyard and Hammarbybacken in the development plan seems very narrow. What would the minimum width be according to you?
5. What risks and benefits do you see with developing a forest area into a park (Eg. Loss of diversity)?
6. The forest area where Sjöstadshöjden might be developed is according to the area analysis (områdesanalysen) of very high value (mycket stort värde), what is it that makes this area so valuable?
7. Will you be involved in the coming detailed plan? What would you consider to be important to look for in a natural value inventory and what scale would you use?
8. Will you be able to use the Swedish Standard "Naturvärdesinventering" in your work with Hammarbyskogen?
9. What are your experiences for how "many" of a red listed species, for example "Tallticka" are needed to stop or change any project?
10. Which parameter would you look at in terms of land and water impacts and on which particular in Hammarbyskogen?
11. Which documents could contribute to be aware of the impact distribution in space and time?

12. How big is the impact about rainwater runoff and flooding potential in this area? Did you consider alternatives?
13. In general, did you consider any sustainable alternatives (location, techniques etc.)?

Heli Rosendahl (City planning office)

1. How many other alternative locations for the school have they analyzed?
    a. Can they build the school in a different part of the city (stadsdel?)
    b. Are there restrictions about building the school close to the existing school, Hammarbyskolan?
2. What is the main purpose of the new planned road? Will it become a bicycle road or a road for cars - and when will this be decided?
3. Do any decisions depend on the results of the other investigations in the area? For example, the covering/over-decking of Hammarbyvägen.
4. What will the distribution be between rental housings and housing cooperatives (bostadsrätter)?
5. Will the part of the forest that is left be a park or a forest? What does "park" mean? Why build a park? Accessibility?
6. How long in the planning process for Sjöstadshöjden have you come?
7. How do you think the new comprehensive plan will affect the planning?
8. Is the plan still to build 500 apartments, 1 school and 1 pre-school? Do these numbers include Sjöstadshöjden?
9. Why don't you consider an EIA?
10. Do you plan to Investigate the Wetlands?
11. Why do you investigate each impact alone and not all together? Water, Traffic, Nature Values are all investigated by different consultancies.

Appendix B. Alternative construction of housing

Figures in appendix B are examples of how buildings in alternative A can be constructed to be integrated in the remaining forest area of Hammarbyskogen and Sjöstadshöjden.

FIGURE 1. WOODEN FAÇADE ON NEWLY BUILT RENTAL HOUSING (TAKLAMPAN) CLOSE TO HAMMARBYSKOGEN (FINN MALMGRENS VÄG). HOUSES ARE CLASSIFIED AS ZERO ENERGY BUILDINGS AND CONSTRUCTED TO SAVE ENERGY THROUGH LOW HEAT LOSS. SOLAR PANELS ARE PLACED ON THE ROOFS TO COMPENSATE FOR ENERGY USAGE. EINAR MATTSSON.

Figure 2. Examples of "green buildings". The first example of an vertical forest, developed in Milan (2014). This type of construction can be used as an mitigation measure to lower forest loss, absorb CO^2 and dust, produce oxygen and increase biodiversity. This example equals a forest the size of 7000 m^2. Stefano Boeri Architetti.

Figure 1. Example "green building" in Playa del Carmen, Mexico with solar panels on the roof and plants on walls and balconies to compensate for green area loss. Blue Playa Real Estate.

Final reflections on general projects

The work of writing an EIS has given rise to a number of issues regarding the work of creating an EIA for projects in the Stockholm region. These are the final reflections from all five groups that have been doing EIA:s of five different areas during this course. The areas were Hammarbyskogen, Kymlinge, Larsboda, Magelungen and Riddersvik.

- The municipalities have sometimes decided to split a larger project into several smaller ones. This can be a sign of them trying to avoid having to make an EIA.
- Most of the municipalities have estimated that an EIA is not needed for the projects. Since some of the impacts in the EIS:s in this paper have been major negative, another sign of the municipalities avoiding to make EIA:s can be said to be found. Together with the municipalities splitting projects into smaller ones, one can say that there is a tendency that the municipalities are showing an "avoidance syndrome" concerning the EIA process.
- Overall, coordination between the regional plans and the local plans is needed. The regional planning is concerning infrastructure while the municipalities themselves are to decide if and where to contribute with new housing units. This have given rise to gaps between goals when state authorities and regional plans count on the municipalities to do their part, while the municipalities have other plans. With this, the regional plan becomes subordinated the local plans, especially since the municipalities have planning monopoly in Sweden and there are no sanctions for not building more housing units or not following the regional plan. There is also a need for infrastructure planning to go well with future housing planning in order to create better conditions for the future.
- Goals to preserve natural values can sometimes stand in conflict with goals of developing infrastructure and the housing situation in Stockholm. Often, the most attractive places are also the most vulnerable.
- There could also be a better collaboration between the municipalities to create better relations and to make sure they are all contributing to reach the regional goals.
- To create better conditions for the EIA process, there should be certain standards and data for the municipalities to provide and keep track of, for example noise level maps.
- Overall, a lack of relevant information have limited the work with these EIA:s. For most of the projects described in this report, a detail development plan has not been available but only "starting PM":s giving an overview of the planned projects. For some, the plans have even changed during the working process, which have caused problems and confusion.
- If an EIA is not carried out, major negative, or positive impacts from a project risks not being found or highlighted. With this report, some major impacts have been found that can help decision makers when developing the proposed new residential areas.

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