4

Expansion of Logistics and Cargo Zone at Arlanda Airport

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Non-technical summary

This report has been developed to present and discuss the effects of the development of Cargo City and Logistic City regarding Swedavia's Draft Master Plan. Swedavia has a long-term goal for Arlanda airport of reaching 70 million travelers by the year 2070 (Swedavia Airports, 2017b). To reach this goal, the airport will have to expand its area as well as increase its capacity. Being Sweden's largest airport, Arlanda constitutes an important access point and center for air cargo in Scandinavia, and part of the development plans for the airport is to expand the air cargo and associated logistics facilities. This development is planned to consist of two parts - expansion of the principal cargo handling area (Cargo City), plus construction of a nearby zone with cargo-related business and service facilities (Logistic City). Currently, Cargo City is found south of Terminal 2 whereas Logistic City is not an existing development but has a proposed location west of runway 1, in close proximity to the E4 motorway.

This Environmental Impact Statement (EIS) aims to examine the effects and possible environmental impacts of increasing the cargo capacity and the area connected to air cargo and logistics, during both the construction and operation phases. Five different development layouts have been reviewed in this EIS. Alternative 1 is to move Cargo City next to the proposed site for Logistic City in between runway 1 and the E4. Alternative 2 is to keep Cargo City in its current location, and only develop Logistic City between the runway and E4. Both of these alternatives contain a high and low exploitation development layout. Additionally, an assessment is made in the case of the site remaining as it is, with no development, also known as the Zero Alternative.

An overview of the main impacts is visualized for each alternative in an impact matrix in Section 4.6.1, Table 4.6. The overall development of Logistic City and Cargo City implies exploitation of natural areas. The major consequences are connected to the loss of natural habitats, which has an immense impact on local landscape, ecology and biodiversity. Other fields that will be negatively affected, but in less extent, are hydrology, air quality and climate, noise, traffic and transport. Cultural heritage could be affected in a positive or negative way depending on the alternative of consideration. Socio-economic factors will mainly be affected in a positive way due to the increase of Cargo City's capacity and employment opportunities. A more detailed description of the impacts for each environmental category is presented in Section 4.5.

The overall assessment recommends keeping Cargo City in its current position and developing Logistic City in the west, such as in the low exploitation alternative presented in Section 4.4.3.2. (Alternative 2L). This alternative will have the least impact on the local environment. Additionally, it could have some positive impacts on some aspects, such as biodiversity, cultural heritage and socio-economic factors. Certain actions are recommended to reduce the risks of environmental impacts during the construction and operation phase. These involve maintaining connections between natural areas, taking measures to reduce the spread of pollution to air, ground and water, as well as designing the development so that the impacts on noise are reduced and objects of cultural value are preserved. Also, it became clear that the

impacts can be reduced by enhancing the cargo handling space efficiency, because less area is then needed for the cargo handling.

Uncertainties concerning the future need for logistic- and cargo facilities prevail, meaning that a development with a lower exploitation degree would make sense in terms of reducing the environmental impacts.

Icke-teknisk sammanfattning

Den här rapporten har tagits fram för att presentera och diskutera effekterna av Swedavias planer på att utveckla Arlandas anläggningar för frakt (Cargo City) och logistik (Logistic City). Swedavia har ett långsiktigt mål om att Arlanda ska kunna ta emot 70 miljoner resenärer år 2070 (Swedavia Airports, 2017b). För att nå det målet behöver flygplatsen expandera och öka sin kapacitet. Som Sveriges största flygplats är Arlanda en viktig anslutningspunkt och ett centrum för flygfrakt i Skandinavien; således ingår expansionen av flygfrakt- och logistikområdet som en del i flygplatsens utvecklingsplaner. Utvecklingen är tänkt att utgöras av två delar – en utvidgning av området för hantering av flygfrakt (Cargo City) och bebyggelse av ett närliggande område för godsrelaterad verksamhet och servicebyggnader (Logistic City). I nuläget ligger Cargo City söder om Terminal 2, medan Logistic City är ett tänkt framtida område väster om startbana 1 – i närheten av E4:an.

Denna miljökonsekvensbeskrivning syftar till att undersöka miljöpåverkan som kan komma att resultera av en ökad lastkapacitet och utvidgning av flygfrakts- och logistikområdena, både under byggnadsarbetet och när verksamheterna har tagits i drift. Fem olika förslagsalternativ har utvärderats i miljökonsekvensbeskrivningen. Alternativ 1 innebär att Cargo City flyttas så att det ligger intill det föreslagna området för Logistic City, mellan bana 1 och E4:an. I Alternativ 2 är det bara Logistic City som byggs väst om startbanan, medan Cargo City behålls i sitt nuvarande läge. För båda alternativen finns ett förslag om hög (H) respektive låg (L) exploateringsgrad. Dessutom har en utvärdering gjorts av det så kallade Nollalternativet, då området förblir i sin nuvarande form utan ny bebyggelse.

I Del 4.6.1, Tabell 4.6 återfinns en översiktlig bild av konsekvenserna för de olika förslagen. Utvecklingen av Logistic City och Cargo City innebär att naturområden tas i anspråk. De huvudsakliga konsekvenserna har koppling till förlusten av naturliga habitat – vilket har en stor påverkan på landskapet och biologiska mångfalden på det lokala planet. Även hydrologi, luftkvalitet och klimat, buller, trafik och transport kommer att påverkas negativt, men i mindre omfattning. Påverkan på kulturarv är positiv i vissa förslag och negativ i andra. Påverkan på socioekonomi är i huvudsak positiv till följd av ökad kapacitet och arbetstillfällen. Miljöpåverkan beskrivs mer i detalj i Del 4.5.

Resultatet av den övergripande bedömningen påvisar att alternativet där Cargo City behålls i sitt nuvarande läge och Logistic City utvecklas väster om startbanan med låg exploateringsgrad rekommenderas, såsom beskrivet i Del 4.4.3.2 (Alternativ 2L). Detta alternativ har minst negativ påverkan på den lokala miljön och kan även ha positiv påverkan inom vissa aspekter såsom biologisk mångfald, kulturarv och socioekonomiska faktorer. Vissa åtgärder rekommenderas för att minska riskerna för miljöpåverkan dels under uppbyggnadsskedet, men även när verksamheterna är i drift. Detta inkluderar åtgärder för att behålla kopplingar mellan naturområden, minska spridningen av föroreningar till luft, mark och vatten, att utforma området på ett sådant sätt att bullernivåer kan hållas nere och att kulturvärden bevaras. Det framkom också att påverkan kan minskas genom att höja effektiviteten avseende använt utrymme i hantering av flygfrakt, eftersom ett mindre

område då behövs för denna hantering. Det finns även osäkerheter i det framtida behovet av frakt- och logistikanläggningar; en låg exploateringsgrad skulle därmed säkerställa en mindre miljöpåverkan innan det är klarlagt att ett större område behöver tas i anspråk.

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4.1. Introduction

4.1.1 Background

Arlanda Airport is Sweden's largest airport, with about 25 million travellers passing through the airport in 2016 (Swedavia Airports, 2017c). Swedavia, the owner and operator of Arlanda, expects that this number will increase to 40 million travellers by the year 2040 (ibid) - a significant increase by any standards. The company has also stated a long-term goal of reaching up to 70 million travellers by the year 2070 (Swedavia Airports, 2017b). In order to meet the demands of the increased number of passengers at Stockholm Arlanda airport, both the capacity and area of the airport will need to expand; making room for more people, goods, and services. Regional Utvecklingsplan för Stockholmsregionen (RUFS) 2010 stresses the importance of Arlandas role as an international airport and its influence on the development of Sweden, also noting its potential to grow as an air cargo terminal (RUFS, 2010).

The airport is also an important entry point and logistics centre for air cargo in Scandinavia, with approximately 200,000 tonnes of goods per year transported through the airport today (Swedavia Airports, 2017b). The region of Stockholm is growing, along with its business sector, which has led to a need for expanding the development of commercial activities at Arlanda airport such as cargo and logistics (Swedavia Airports, 2017a). Current trends indicate that air cargo will take a greater share of space on passenger planes rather than on strictly cargo planes (Swedavia Airports, 2016), possibly indicating a need to expand logistic operations in cargo transfers.

4.1.2 Site description

Cargo City is currently the centre for both air cargo and associated logistics. The area is found south of Terminal 2 with a direct connection to both Arlanda airport and the E4 motorway (Airport City, Stockholm 2017). Cargo City has a building permit of around 20 ha, of which more than half is not being used (Swedavia Airports, 2017b), and the area is expected to increase by around 15 ha of new buildings for operations concerning cargo and logistics (Swedavia Airports, 2017a). However, the total area actually needed in order to facilitate a capacity to handle the future increase in cargo is unclear. Also the placement of the expansion is unclear, and could take place either at the current location or west of runway 1 (Swedavia airports, 2017b).

Logistic City will be a completely new development with a proposed site west of runway 1. Swedavia has plans to strategically locate it between the airport and the E4, allowing it to serve as a central spot for commerce, light industry, passenger/roadside service and logistics. The development would be composed of two parts: Logistic City 1 with services such as hotels, offices, restaurants and shopping facilities and Logistic City 2 with warehouses for bigger logistical companies and transportation facilities (Swedavia Airports, 2017a). The proposed construction sites for Cargo- and Logistic City are within the marked area in figure 4.1.

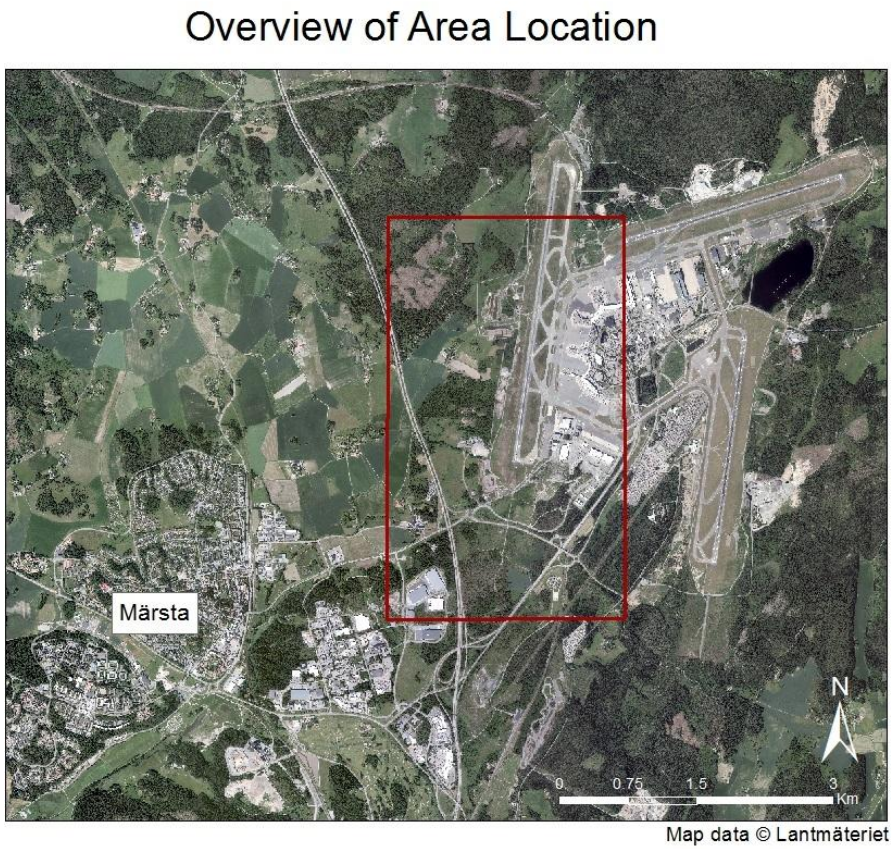


Figure 4.1. Map showing the location of the study area in relation to Arlanda airport and Märsta.

4.2 Methods

4.2.1 Scoping Matrix

In the scoping process we used a checklist designed by the European Commission in order to identify actions relating to the construction and operation of our project, as well as potential impact categories affected as a result (European Commission, 2001).

4.2.2 Impact Matrix

The following impact assessment matrix, originally designed by Ekologigruppen AB (Kloth *et al.,* 2011), simplified and used by last year's students in the EIA course, shows a five-graded scale ranging from major positive impact to major negative impact. It was used in Section 4.6.1 to summarize the impacts associated with each environmental category analysed in this EIA. The definitions for each level of impact can be found in Table 4.1.

Table 4.1. Impact matrix used in Section 4.6.1 to assess the different environmental impacts for each of the alternatives.

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.

4.2.3 Field trips

Two field visits were conducted at Arlanda airport to observe the study areas and to obtain more information regarding Swedavia's development plans. Besides field observations, an interview with a cargo manager was conducted (for interview questions see Appendix).

4.2.4 GIS

In order to understand the size and scale of our alternatives, and to present the different alternatives, we used the Geographic Information System program ArcMap 10.5 (ESRI, 2016).

4.2.5 Strategic Assessment of Cargo Handling Efficiency

How much space is needed for the future development of Cargo City, to accommodate the increase of cargo, is of strategic importance. The size of Cargo City in terms of land occupation greatly influences the environmental impacts that the project will have. Moreover, it influences how much space is left for other use (e.g. other constructions or green spaces) and in the event that Cargo City moves to the west, it determines how much space is left for the development of Logistic City.

In exploring alternatives for the project, we sought to understand the relationship between cargo handling and area (need for space). We found that the area needed for a Cargo City development is a function of both efficiencies in cargo handling and cargo volume in tonnes per year. To determine cargo volume, we looked at a projected growth curve given in Swedavia's Draft Masterplan (Swedavia Airports, 2017b) and used their estimated tons per year at 2070 (Figure 4.2). Based on Swedavia's air cargo prognosis for 2070 (Figure 4.2), we calculated the need for space (m^2) of potential expansions of Arlanda's cargo area in order to be able to accommodate the increased air cargo according to both low (600,000 tonnes) and high (1 million tonnes) expectations for 2070. For this report, these increased volumes of air cargo are viewed as scenarios rather than projections, since changes many decades into the future are uncertain. Given that the change in the previous ten years does not follow a clear pattern, a steady increase in volumes is not certain.

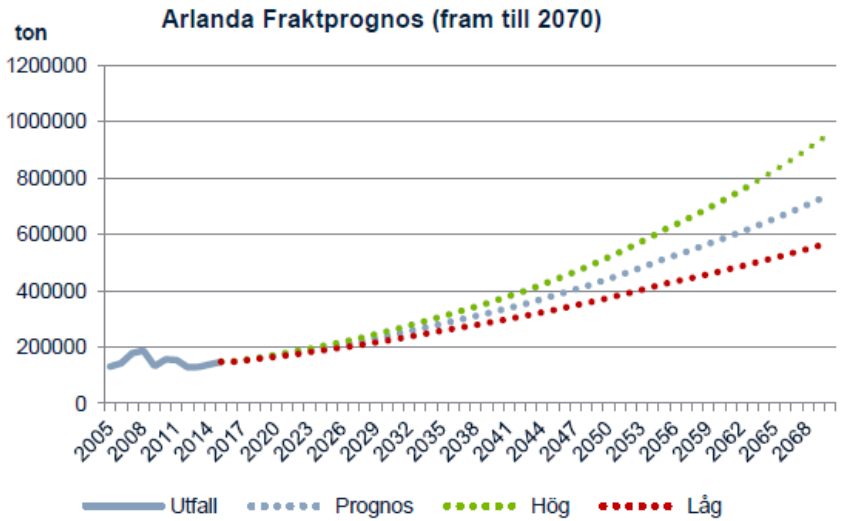


Figure 4.2. Air cargo 2005 to 2016 and Swedavia's long term air cargo prognosis for Arlanda airport. Green line: high expectations, red line: low expectations, grey line: average prognosis (Swedavia Airports, 2017c).

To estimate the magnitudes of potential expansions of Cargo City triggered by increased air cargo, we used three different space efficiency factors (need for space in square meters per tonne of cargo handling per year). The low space efficiency factor is based on Arlanda's current efficiency. Arlanda has currently been handling up to 200,000 tonnes of cargo per year in a roughly estimated total cargo area of 20 ha (area measured on ArcMap 10.5 (ESRI, 2016)). Based on this data, we estimated that Arlanda utilizes approximately 1 m^2 of land area to handle one tonne of cargo. Consequently, Arlanda's cargo space efficiency factor was estimated 1 m^2/t

The high space efficiency factor was calculated based on Hong Kong international airport (HKIA). There 4.5 million tonnes of cargo are currently handled per year - making it the world's leading airport for air cargo (Statista, 2017) - in a total area of about 188 ha (measured using Google Maps). The area was approximated to 200 ha to incorporate uncertainties due to the rough method of calculation. Based on the data, we calculated that the space efficiency factor of HKIA is 0.44 m^2/tonne of cargo. The factor was approximated to 0.5 $m^2/t/y$. The middle space efficiency factor was then set at 0.75 m^2/t, which is the medium value between the two airports. The results are shown in Table 4.2.

For this report it is assumed that Arlanda has the capability to increase its efficiency regarding the use of land needed for cargo and air cargo handling similarly to HKIA. This could presumably be done with a more normalized distribution of cargo and air cargo handling during 24 hours per day, as well as with more efficient building construction in Cargo City (e.g. concentrated buildings that minimize the need for surrounding space). Since lack of space is a much more obvious issue in Hong Kong than in Sweden, this efficiency might seem unrealistic or unnecessarily high. These development plans are however on long-term, which means that many uncertainties, such as new innovations or the future land need around Arlanda, might result in possibilities and/or need for a highly efficient cargo handling. Also, maps of a scenario with low-efficient cargo handling is presented in Section 4.4.1 (Figures 4.5 and 4.6) for comparison.

The report proceeds with an Environmental Impact Assessment (EIA) based on the assumption that the future Cargo City will be developed with the highest space efficiency factor (0.5 $m^2/t/y$) (See Table 4.2). We believe that a strategic increase of space efficiency in Cargo City is the most environmentally sound scenario, while enabling for the necessary capacity development.

Table 4.2. Area demand in hectares (= 10,000 m^2) of cargo space for the different cargo volume alternatives.

	Space efficiency factor (m^2/t)	Cargo Low Exp. (600 kt/yr) (ha)	Cargo High Exp. (1 Mt/yr) (ha)
High Efficiency	0.5	30	50
Mid Efficiency	0.75	45	75
Low Efficiency	1	60	100

4.3. Boundaries

4.3.1 Spatial Boundary

This Environmental Impact Statement (EIS) examines impacts within Sigtuna municipality, with a focus on the area around Arlanda airport. We use the drawn boundaries for the national interest of Arlanda, which is the same as the area within the noise boundary of under 55 dBA (Figure 4.3) (Sigtuna Kommun, 2006). Since the study area is of national interest, it is protected under the Swedish Environmental Code. The code states that the area should be protected against measures that can significantly obstruct accessibility and the possibility to utilise the area (Ch.3, §8) (Swedavia airports, 2017c).

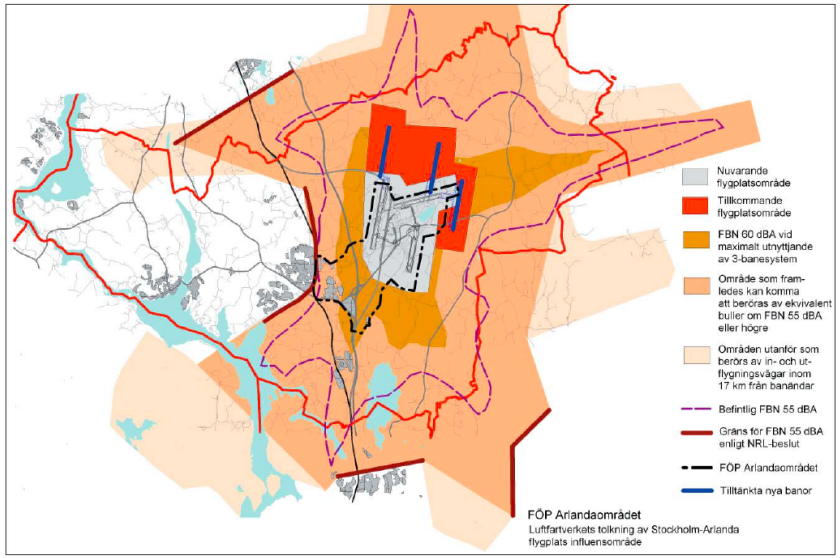


Figure 4.3. The area where noise levels do not exceed 55 dBA displayed in medium orange (Sigtuna Kommun, 2006).

4.3.2 Temporal Boundary

The proposed expansion and construction of Cargo City and Logistic City is in the earliest stage of development, therefore little is known about the project timeline (Swedavia Airports, 2017b). In this EIS we assume that construction will commence within the next 10 years and that the operation phase will occur before 2070. Therefore, the temporal boundaries of this EIS are set to the year 2070. The decommissioning phase is not taken into account as this activity is not planned within the time frame of this EIS.

4.3.3 Comment on construction vs. operation phase of Cargo City

The development of the new Logistic- and Cargo City will be a gradual process involving the utilisation of both existing and new built up areas. In other words, with a potential move of Cargo City to the west, all of it would not need to be moved at once and during a part of the construction phase Cargo City would be partly located at its current location in the south as well as in its new location in the west. However, this EIS does not include an alternative where this situation is displayed as the long-term goal is to have all of Cargo City in the same location.

4.4 Alternatives

4.4.1 Considered degree of exploitation

When carrying out an EIA, possible alternative approaches for the project should be investigated. It is an important part of the process as it gives decision-makers a possibility to acknowledge the differences in environmental impacts between alternatives and the opportunity to choose the alternative leading to the least amount of environmental damage (Glasson *et al.,* 2005).

Two options of the development of Cargo- and Logistic City have been identified in this EIA, with two alternatives per option displaying a high exploitation and a low exploitation degree. Including the Zero Alternative, a total of five alternatives have been compiled and are described below. They were chosen after conducting a strategic assessment of the cargo area, as described in Section 4.2.5. The land area for Logistic City was approximated from Swedavia's Draft Master Plan at 140 ha in the case of cargo placement in the south and 130 ha in the case of cargo placement to the west of runway 1.

To get an idea of what facilities could be contained in the different alternatives, a suggestion of land use in Logistic City is presented in Figure 4.4 (Cargo City is assumed to be used entirely for air cargo-handling). When working with the different alternatives, these percentages are assumed to be the same for both the high and the low exploitation alternatives.

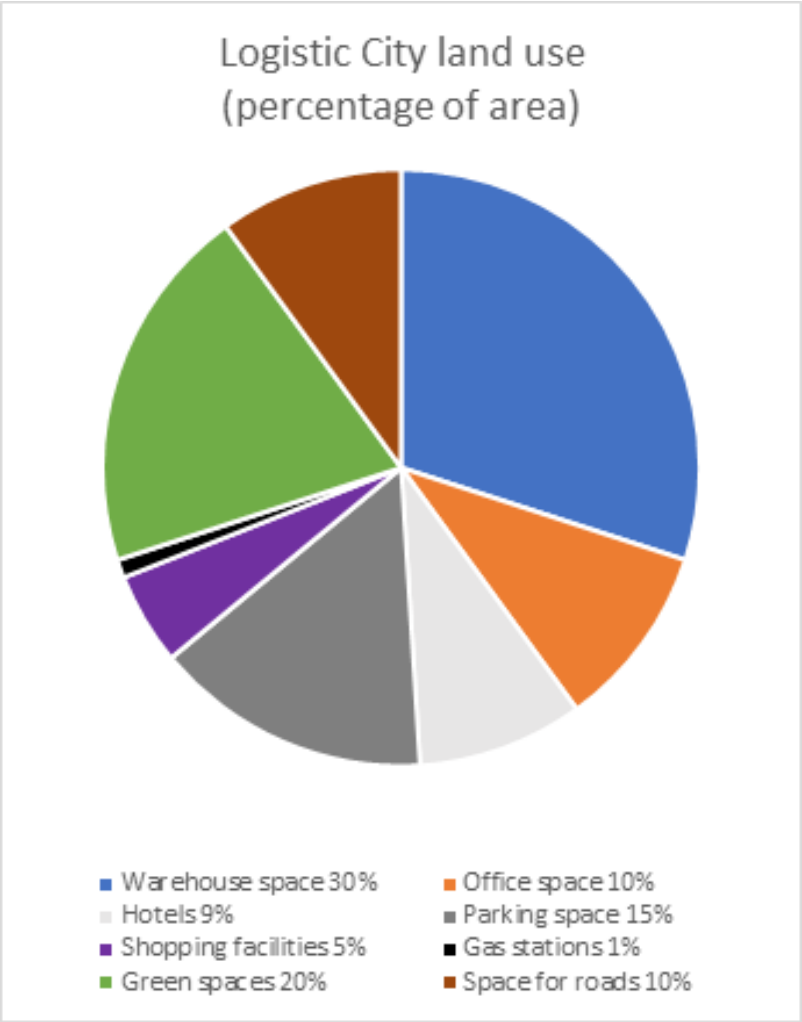


Figure 4.4. Suggestion of land use for Logistic City.

In the high exploitation alternatives 1H and 2H this would correspond to approximately:

- 5-6 hotels the size of Radisson Blu Arlandia
- Shopping facilities occupying the same area as Mall of Scandinavia
- Around 4 500 parking spaces (more with multi-levels)
- 40 ha of warehouse ground space (possibly with some office space on top)
- 13.5 ha of office ground space

For the lower exploitation Alternatives 1L and 2L these numbers would be halved.

Furthermore, while in the report only the high-efficient Cargo City is investigated, Figures 4.5 and 4.6 illustrate the area that would be occupied if the future Cargo City would have the same space efficiency as it has today (1 m^2/t/y), with the high-volume scenarios as example. This would mean that Cargo City occupies 100 ha, and together with a high exploitation version of Logistic City the total occupied area would then be 230-240 ha. The expansion seems possible in Figure 4.6 (where Cargo City is kept to the south), but the exact expansion in Figure 4.5 would interfere with existing facilities. However, the maps indicate the size of this potential development and not necessarily exact expansion patterns. Note that the efficiency factor is only affecting Cargo City; Logistic City has the same size and location as in the high exploitation versions of the alternatives that follow below.

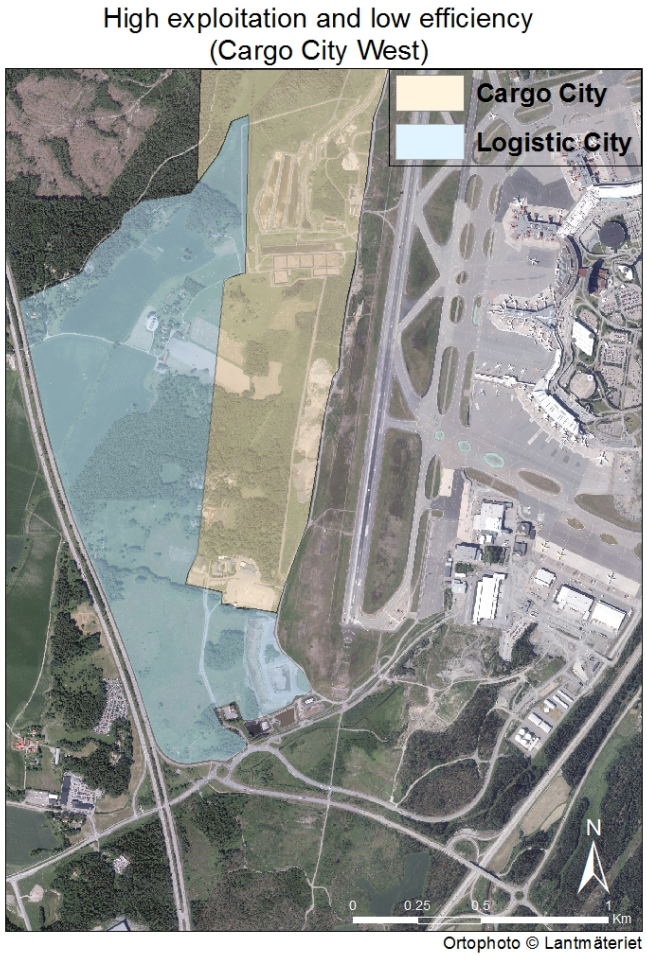


Figure 4.5. Map showing the development areas of Cargo- and Logistic City with a high exploitation and low efficiency, with a location to the west of runway 1.



Figure 4.6. Map showing the development areas of Cargo- and Logistic City with a high exploitation and low efficiency, with Logistic City located to the west and Cargo City to the south.

4.4.1 Zero Alternative

The Zero Alternative shows what would happen if the project was not carried out. In other words, it shows what the impacts would be if there was no development of Logistic City and if Cargo City remained as it is in its current location south of the airport.



Figure 4.7. Map showing the Zero Alternative with the current Cargo City.

4.4.2 Alternative 1

The proposal concerning Alternative 1 is to build Logistic City to the west of runway 1 and move Cargo City from its current location in the south, placing it alongside Logistic City next to runway 1.

4.4.2.1 West alternative with a high exploitation degree (1H)

The land area used to develop Logistic City and Cargo City will be 130 ha and 50 ha respectively. The development will be dense and comprehensive with no preservation of current land within the study area, except for a few buildings in one of the villages in the area comprised of service facilities belonging to the airport and ponds for treatment of glycogen and storm water. A visualisation of the area can be seen in Figure 4.8.

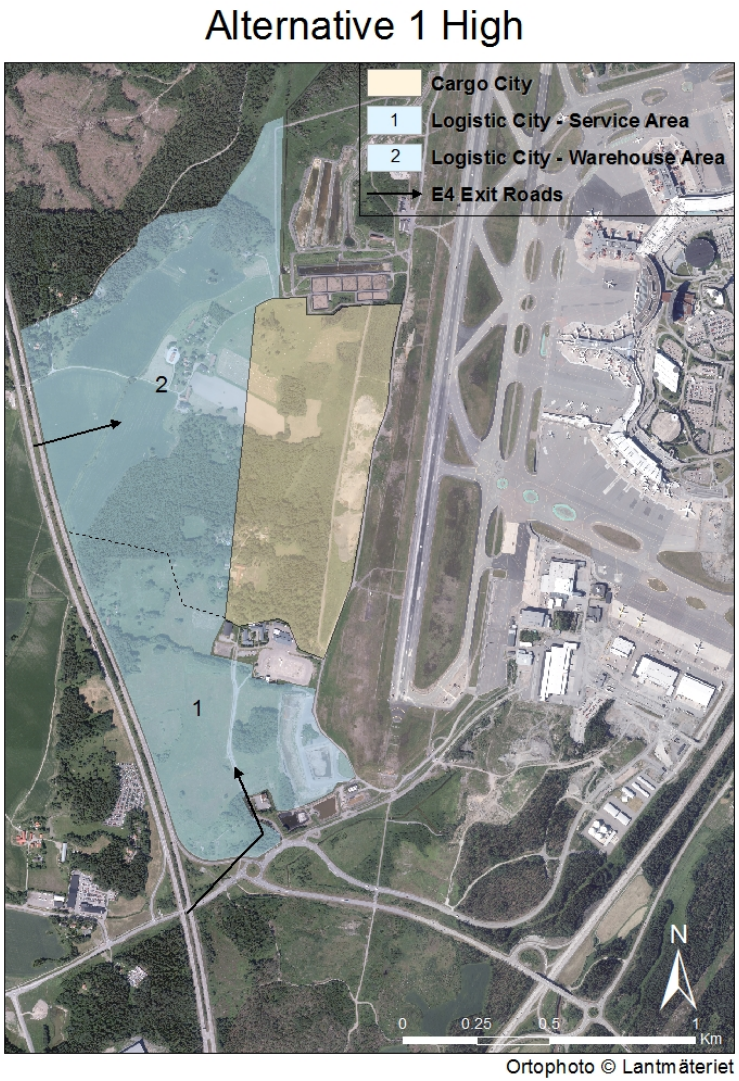


Figure 4.8. Map showing the development area of Alternative 1H.

4.4.2.2 West alternative with a low exploitation degree (1L)

The land area used to develop Logistic City and Cargo City will be 70 ha and 30 ha respectively. The development will be "airy" and compartmentalised with preservation of natural and cultural structures within the study area, such as pasturelands, wooded areas and the villages in the area. A visualisation of the area can be seen in Figure 4.9.



Figure 4.9. Map showing the development area of Alternative 1L.

4.4.3. Alternative 2

The proposal concerning Alternative 2 is to build Logistic City west of runway 1, with Cargo City remaining in its current location to the south (with a potential southward expansion).

4.4.3.1 South alternative with a high exploitation degree (2H)

The land area used to develop Logistic City and Cargo City will be 140 ha and 50 ha respectively. The development will be dense and comprehensive with minor preservation of current land within the study area. A strip of land running parallel to runway 1, consisting of a wooded area and pastoral land, will remain in its current state. The service facilities in one of the villages and the ponds for treatment of glycogen and storm water will also be preserved. A visualisation of the area can be seen in Figure 4.10.

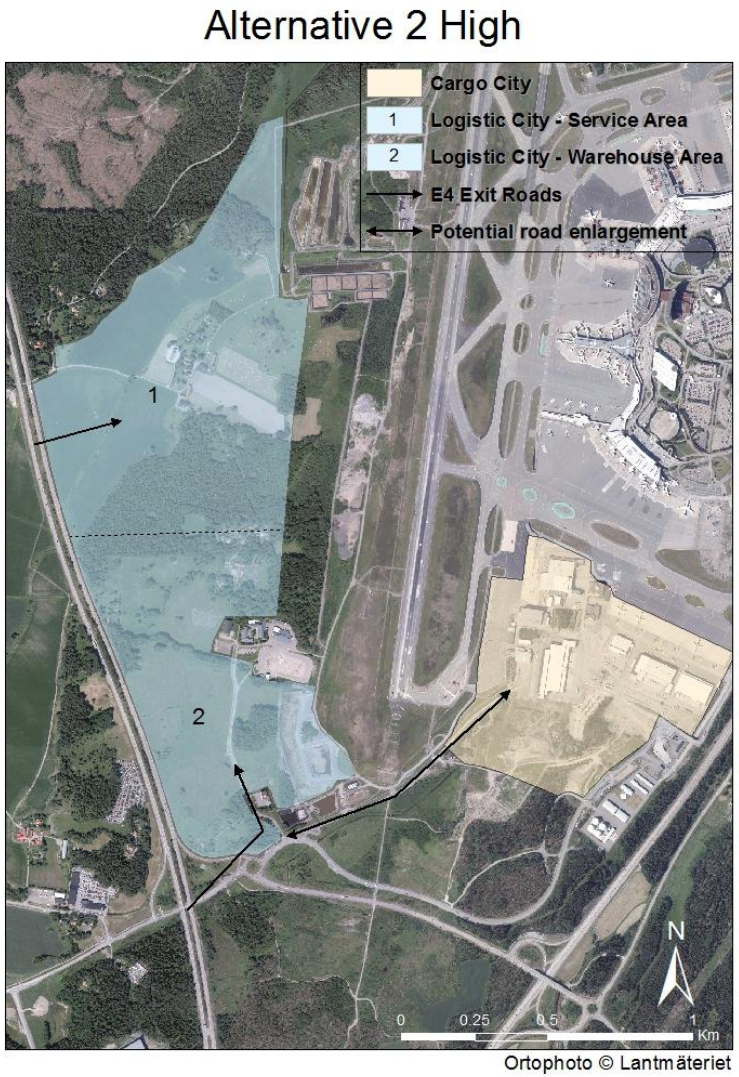


Figure 4.10. Map showing the development area of Alternative 2H.

4.4.3.2 South alternative with a low exploitation degree (2L)

The land area used to develop Logistic City and Cargo City will be 70 ha and 30 ha respectively. The development will be "airy" and compartmentalised with preservation of natural and cultural structures within the study area, such as pasturelands, wooded areas and the villages in the area. A visualisation of the area can be seen in Figure 4.11.



Figure 4.11. Map showing the development area of Alternative 2L.

4.5. Environmental Baseline and Assessment of Impacts

4.5.1 Landscape and Ecology

4.5.1.1 Baseline

The landscape in the study area is mostly flat, with minor variations in topography (Haglund *et al.,* 2010). The present Cargo City is located in the south of Arlanda airport on the east of runway 1. It is a built environment on around 20 ha including infrastructure facilities for air cargo and other cargo handling, such as buildings for temporary storage, parking areas, road constructions and spaces for cargo airplanes and truck load. The landscape south of Cargo City is an undeveloped area with a mixture of rocky and grassland habitats, basic road constructions and coniferous forest to the east. West of runway 1 the landscape consists of arable land, coniferous and deciduous patches of forest, open pastures and scarce urban infrastructures. The study site has five areas of very high natural value, three of them are listed under the Natura-2000 protected areas network (Table 4.3) (Haglund *et al.,* 2010).

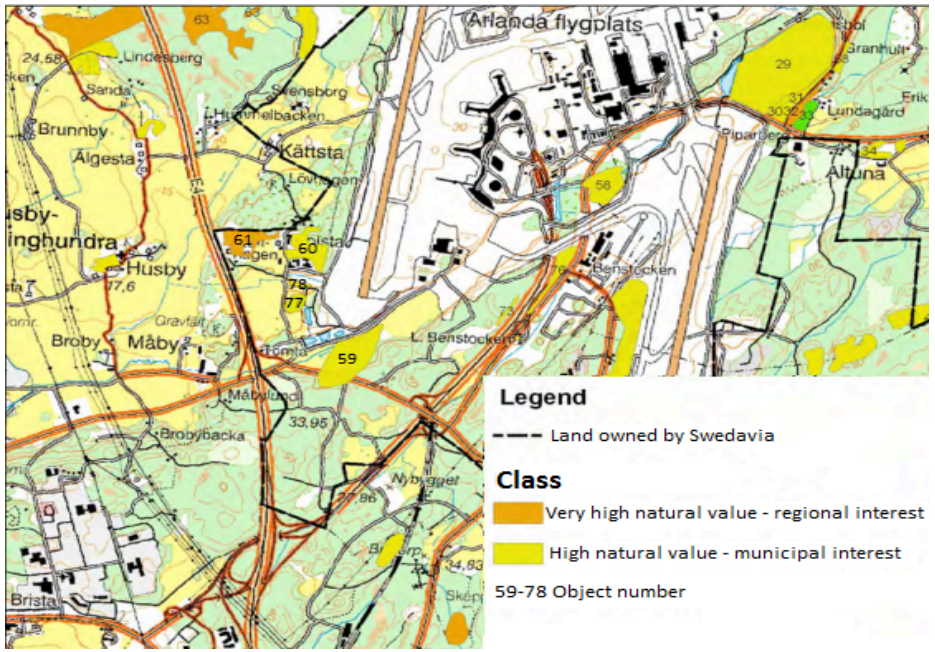


Figure 4.12. Areas of high natural interest in the region around Arlanda airport (Haglund et al., 2010 [modified]).

Table 4.3. Natural areas of significance in the study site.

Object no.	Landscape/Habitat	Natural value	Natura-2000 area	Area (m^2)
60	Wooded pasture land mixed with large oak trees and fragments of fine flora	EU/National interest	Yes	57,400
61	Grassland pastures on siliceous substrates with large oak trees	EU/National interest	Yes	48,800
78	Hill with large oak trees	EU/National interest	Yes	Unknown
77	Mature deciduous oak and ash forest	Very high value - municipal interest	No	Unknown
59	Shrubs and grasslands with sandy habitats	Municipal interest	No	Unknown

4.5.1.2 Alternatives

Zero Alternative

In this alternative, the area west of runway 1 would remain unexploited, meaning that the current landscape would be preserved. The areas of high significance, including pasture lands and large oak trees, would remain untouched. According to Sigtuna Kommun (2009), valuable pasture lands should be preserved by increasing the number of grazing animals and keeping the landscape open. Moreover, the coniferous and deciduous forests, as well as the agricultural lands and scarce urban settlements will be preserved.

In summary: The overall assessment is that the Zero Alternative will have no notable impact since the current landscape will remain as it is.

Alternative 1H (West)

The high exploitation alternative with both Cargo- and Logistic City developed on the west would lead to a major change of the landscape west of runway 1. However, it would leave the area south of current Cargo City, which is of little natural and cultural interest, unexploited. The landscape west of runway 1 would be dominated by urbanised and built-up areas with extensive infrastructure development. As a consequence, the highly significant areas, including the Natura-2000 areas located at the site, would be threatened, leading not only to habitat loss of high value natural areas (such as pasture lands and large oak trees), but also to associated biodiversity loss and ecosystem services such as grazing. Moreover, most of the forest and arable areas will be lost.

The construction phase of the developments might take a long time, since the area will be transformed gradually. Consequently, the study area will be dominated by construction sites until the construction phase (or the first part of it) is completed.

In summary: The overall assessment is that Alternative 1H will have a major negative impact due to high urbanization of the area west of runway 1.

Alternative 1L (West)

The realisation of Alternative 1L would lead to a considerable change of the landscape west of runway 1. However, this alternative would enable most parts of areas with high value and the Natura 2000 areas to be preserved (pasture lands and large oak trees), as well as some parts of the forest, the arable land and the current settlements. However, the resulting landscape would be characterized by urban settlements and infrastructure. The area south of the current Cargo City, which has low natural and cultural interest, would be left unexploited.

In regards to the construction phase, the study area will be dominated by construction sites until its completion, but in a smaller spatial and temporal scale in comparison to Alternative 1H.

In summary: The overall assessment is that Alternative 1L will have a minor negative impact due to considerable urbanization of the area west of runway 1 but with areas of high natural value preserved.

Alternative 2H (South)

This alternative would lead to major changes of the landscape west of runway 1, as well as for the landscape south of the current Cargo City. The landscape west of runway 1 will be dominated by urban infrastructure similar to Alternative 1H. However, an area of approximately 30 ha in proximity to runway 1 will remain unoccupied, with a small part of a high value Natura-2000 pasture land with large oak trees and a part of the forest to be preserved. However, this alternative would lead to exploitation of the area south of current Cargo City. As noted earlier, this area is of low natural and cultural value.

The construction phase would be similar to Alternative 1H, with additional construction sites in the south.

In summary: The overall assessment is that Alternative 2H will have a major negative impact due to high urbanization of areas west of runway 1 and south of Cargo City.

Alternative 2L (South)

Low exploitation in the west and south would lead to similar considerable changes of the landscape west of runway 1 as Alternative 1L, as well as a moderate expansion of infrastructure development south of current Cargo City. This development would not affect any significant habitats and would increase the utilization of currently undeveloped land with low natural value.

The construction phase would be similar to Alternative 1L, with additional construction sites in the south.

In summary: The overall assessment is that Alternative 2L will have a minor negative impact due to considerable urbanization of both areas west of runway 1 and south of Cargo City but with areas of high natural value preserved.

4.5.1.3 Mitigation measures

In the development of our alternatives we have accounted for 20 % of the land to consist of green spaces. These green spaces could be designed and placed in a way that would incorporate and safeguard the preservation of natural areas with high value. Moreover, the design and distribution of green spaces could significantly improve the aesthetic value of the urbanized landscape and create "green oases" among the concrete, enhancing both the aesthetic, the recreational and the ecological value of the landscape.

4.5.2 Biodiversity

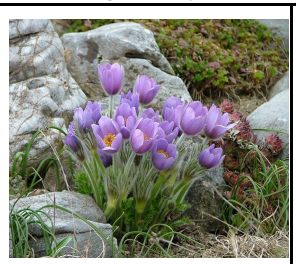
4.5.2.1 Baseline

The natural areas described in Section 4.5.1 (Table 4.3) are based on the richness and rarity of species and ecological processes that exist in these small but important habitats (Haglund *et al*., 2010). These areas will be examined in the analysis of the ecological impact assessment of Logistic- and Cargo City in this project by making use of data presented by Ekologigruppen AB in their study of the Arlanda region (Haglund *et al.,* 2010). Species both in and outside the project area are included as their proximity and biology may be affected by development.

A main concept concerning biodiversity is the connectivity between habitats which affects the species ability to achieve a natural distribution. Connectivity can be broken down into structural connectivity and functional connectivity. The natural connectivity is negatively affected due to the fragmentation of the habitats, which seriously affects the populations of the different species (Monkkonen & Reunnen, 1999). In the project area between object 60 and object 61 (Table 4.3), there exists a structural connectivity in a mixed landscape with the likely presence of a functional connectivity. However, the other object areas, in the middle of a fragmented landscape, do not present a structural connectivity. Due to the low human population in the area, fauna may still move between areas in spite of ecological fragmentation.

The great crested newt (*Triturus cristatus*) is a protected species identified in the Arlanda area, according to the EU Habitats Directive and the Species Protection Ordinance (Haglund *et al.,* 2010). The Habitats Directive states that a species listed here should not be affected in a way that could lead to negative impacts on the population, not even on a local scale (Haglund *et al.* 2010). Listed below are some of the red listed species identified in conservation object areas in the proposed area for the development of Logistic City.

Table 4.4. Red-listed species in Arlanda Logistic City area.

		
Common name (Sp.): **False Flax** *(Camelina microcarpa)* Protection Category: **Red List** (VU) Object (table 3): **59** Location: Flight area Lilla Benstocken	Common name (Sp.): **Pasque Flower** (*Pulsatilla vulgaris*) Protection Category: **Red list** (VU) Object (table 3): **60** Location: Pasture lands v Kolsta	Common name (Sp.): **Common linnet** (*Carduelis cannabina*) Protection Category: **Red List** (NT) Object (table 3): **60** Location: Pasture lands v Kolsta

Another aspect to consider are three areas of open silicate grasses and artificial flora that have national values (objects 60 and 61 in Table 4.3). In the Stenhagen area (object 61), there is an unploughed natural pasture which is very rare and has a rich pasture flora with the presence of signal species with high or very high signal value. Of these, it is of national interest to preserve this sandy pasture land, where no less than nine red-listed meadowsweet species have been found. Within these habitats it is worth highlighting the presence of several species indicating natural pastures, some of which are endangered because they are areas with a certain degree of rarity. The most protected species are either invertebrates, birds or butterflies (Table 4.5) (Haglund *et al.,* 2010).

Table 4.5. Red-listed species in areas around the airport and areas of influence.

	
Common name (Sp.): **Small blue** *(Cupido minimus)*	Common name (Sp.): **Eurasian wryneck** (*Jynx torquilla)*

4.5.2.2 Alternatives

Zero Alternative

In the case of conserving the current area, the present object areas will continue to be fragmented due to the cultivated areas. The actual impacts could become more severe in the future due to the expected increase in flights and traffic if no mitigation measures are implemented.

In summary: The overall assessment is that the Zero Alternative will have a minor negative impact due to the current and future operations at Arlanda airport.

Alternative 1H (West)

If the whole project area is developed as proposed in Alternative 1H, the intervention of the four object natural habitats for EU/national and municipality interest value (objects 61, 60, 77 and 78 in Table 4.3) that are in the area, would be the most significant impact. This is because of the area's particular biodiversity, ecological function and economical value in the case of younger broad leaved deciduous forest. The habitats of at least three species from IUCN Red List of threatened Species will disappear affecting its conservation status (*C. microcarpa, P. vulgaris and C. cannabina*).

Fragmentation and loss of the object areas and the development of the Logistic City will negatively affect the ecological functions of the region's landscape due the magnitude of the landscape transformation. For example, the forest coverage provides an ecosystem service with respect to noise reduction. Bearing in mind that a large part of the forest will disappear and that it is close to runway 1, it is very possible that the noise will increase, creating an impact on the local fauna in the areas adjacent to the project area.

During the construction, the increase of machinery and the activity itself will produce more noise and vibrations which can seriously affect the fauna within the area and around it. The presence of many people working in the area could disturb the fauna, especially during seasons of reproduction, affecting local population sizes. This could also occur during the operation phase due to noise and increased traffic, which will prevent species from making use of green areas.

Light-pollution through large scale illumination of facilities radically alters nocturnal animals' natural rhythm by turning night into day. Ecological light-pollution has demonstrable effects on the behavioural and population ecology of organisms in natural settings (Longcore and Rich, 2004). By increasing light intensity during the construction and the operation activities, population dynamics of some fauna species sensitive to light regimes in the area could be affected.

In summary: The overall assessment is that Alternative 1H will have a major negative impact due to the loss of ecological functions with 100 % irreversibility.

Alternative 1L (West)

In the case of Alternative 1L with a low exploitation rate, four important natural areas will be excluded from the construction area. However, there are still some impacts that the construction and operation of Logistic- and Cargo City are going to have on the biodiversity and ecological processes within the area.

During the construction phase, it will be necessary to clear a major part of the natural forest, especially in order to develop Cargo City, sacrificing one of the natural areas of municipal interest identified by Haglund *et al.,* (2010). This clearance will cause fragmentation of the landscape which would interrupt the connectivity between the natural object areas, affecting the movements of fauna and ecological dynamics.

As in Alternative 1H, the noise pollution could increase because of deforestation and the use of machinery during the construction phase, disturbing fauna in the natural areas. During the operation of Logistic- and Cargo City, the density of traffic, noise, and people will increase which could cause disturbance and temporary displacement of wildlife,

in terms of higher chance for roadkill and decreased reproduction rate. As in Alternative 1H, light pollution could affect nocturnal species populations too, but perhaps to a lesser magnitude due to the smaller size in construction area.

In one natural interest area west of runway 1, the impacts of developing Logistic City will be irreversible and the fragmentation of the area that will isolate the other natural interest areas will affect the species populations over time unless a robust mitigation plan is implemented.

In summary: The overall assessment is that Alternative 1L will have a minor negative impact.

Alternative 2H (South)

The majority of the impacts in Alternative 2H are the same as those for Alternative 1H. Due to the southern placement of Cargo City, the undeveloped space existing in-between Logistic City and runway 1 can remain, reducing noise from airplanes just as today.

In regards to the area planned for expansion of Cargo City, noise and light-pollution during the construction phase and operation phase could disturb species living in natural interest area 59, identified by Haglund *et al.,* (2010).

In summary: The overall assessment is that Alternative 2H will have a major negative impact due to the loss of ecological functions with a 90 % irreversibility.

Alternative 2L (South)

Developing this alternative, as in Alternative 1L there will be a choice to leave five important natural areas out from the construction influenced area, but the landscape will also be fragmented and the structural connectivity between the areas will be affected. However, there are patches that could work as possible ecological corridors closer to runway 1.

For the construction phase, it will be necessary to clear one part of the natural forest, especially that between the natural interest areas 60 and 61, affecting the movement of fauna and ecological dynamics.

As in the other alternatives, the noise pollution could increase during construction, disturbing the fauna in the natural areas and the people close to the airport. As Swedavia wants to develop a sustainable project in the logistics area, there is an opportunity to develop a green area between natural areas 60 and 61 (Table 4.3), which could substantially reduce negative impacts.

As in Alternatives 1H, 1L and 2H, during the operation of the new logistic area and the cargo area, traffic, noise and people will increase, which will cause disturbance to wildlife and displacement, with a possible increase of roadkill and decrease in reproduction rate. During the operation, light pollution is going to be another anthropological impact, which will affect nocturnal species population.

In summary: The overall assessment is that Alternative 2L will have a minor negative impact with the potential of reversibility, and in some parts a minor positive impact if a sustainable design plan is developed.

4.5.2.3 Mitigation measures

The loss of some red-listed plant species from the Logistic City area cannot be fully mitigated as the habitat loss is permanent and it is not likely that all the individuals of listed species can be translocated.

Mitigation measures for the remaining alternatives (1H, 1L, 2H, and 2L) could involve using the 20% determined green area to conserve the existing natural areas. The pedestrian paths can be designed to retain the naturalness of the landscape. No alien species should be sown, only native species for the design of the gardens.

According to Alternatives 1H, 1L and 2H where natural areas will be affected, a green compensation plan should be adopted depending on the County Administrative Board's decision. In the case of Alternative 1L and 2L, the green areas could be used for wildlife ecological corridors between the areas of national and municipal interest (objects 60, 61, 77, 78 in Table 4.3). These corridors could consist of bridges or tunnels for fauna movements, taking into account the location of roads or small pathways for recreation (Figure 4.13 and 4.14).

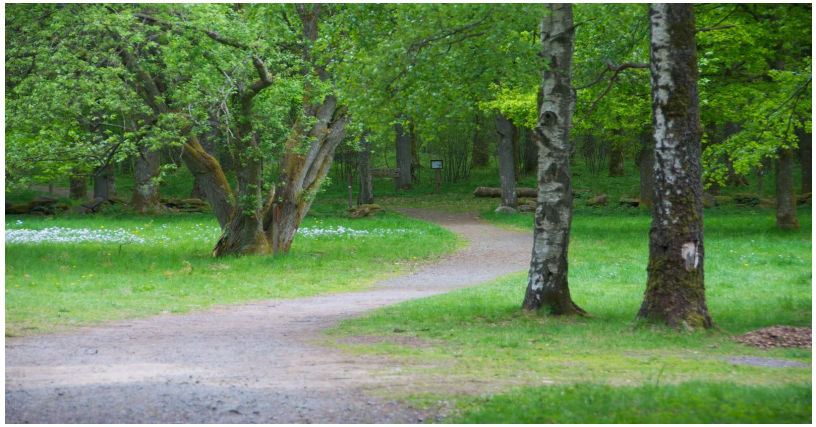


Figure 4.13. Example of natural pathway to connect the object areas 60 and 61 (Table 3) (Huvudfoting, 2016).



Figure 4.14. Example of a wildlife corridor tunnel (Eisenberg, 2015).

In order to mitigate light pollution, warm directed lights can be used in the exterior or gardens in order to diminish impacts on nocturnal species (see Figure 4.15). All lighting shall be of minimum necessary brightness consistent with worker safety. High illumination areas not occupied on a continuous basis shall have switches or motion detectors to light the area only when occupied (Environmental Vision, 2012).

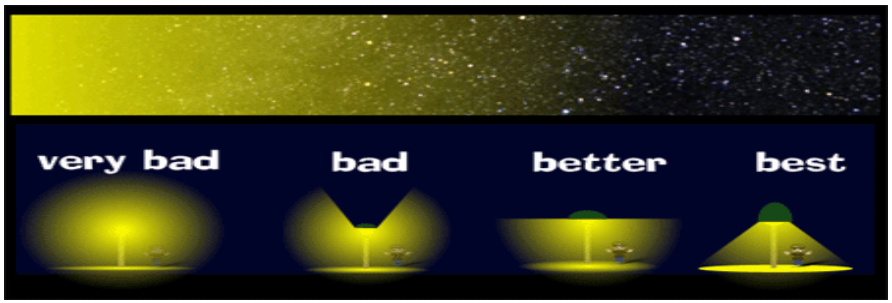


Figure 4.15. Examples of how to project direct light (Glaser, 2014).

4.5.3 Cultural heritage

4.5.3.1 Baseline

Areas with cultural value have been identified around Arlanda airport by Sigtuna municipality, including areas in-between runway 1 and the E4 which is where Logistic City is to be built (Figure 4.16) (Sigtuna kommun, 2006; Swedavia airports, 2017). The villages Kolsta and Kättsta are located in this area, consisting of old farmhouses, some of which are built in the 18- and 1900s. A network of collapsed stone walls, which have mostly been identified as remains of cattle paths and fences, can also be found in this area. They are most likely remnants from the Iron Age and the longest documented walls stretch over several hundred metres. Other remnants from the Iron Age can be found in the area, such as ancient cemeteries adjacent to the stone walls. Furthermore, remnants of an old road network connecting the villages in the area can be traced back to the 17- and 1800s (Bratt & Källman, 1985). All ancient remnants older than before 1850 are protected by the Cultural Environment Act (Kulturmiljölag SFS 1988:950, Ch 2) (Sigtuna Kommun, 2014b; Sveriges riksdag, 2017).

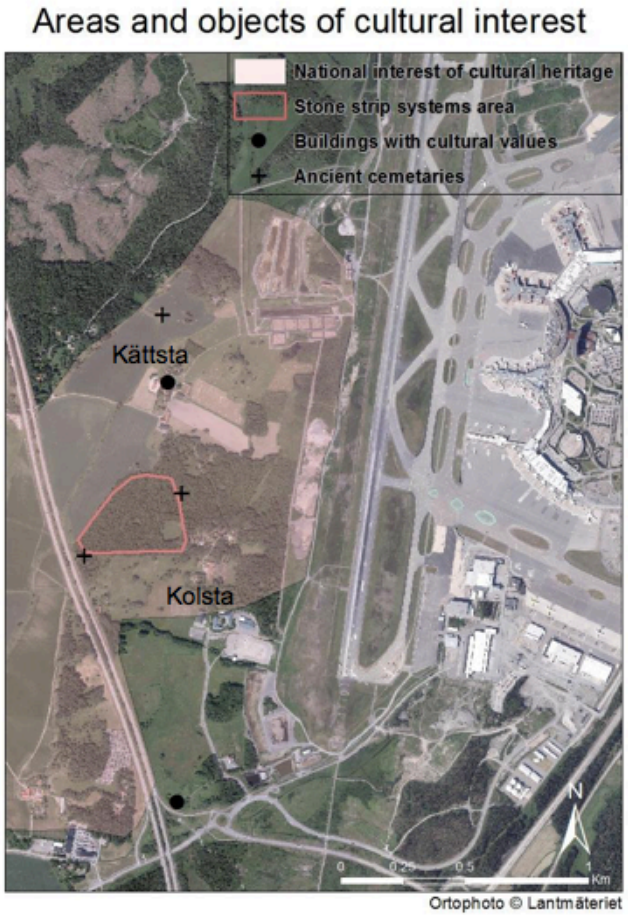


Figure 4.16. Map showing cultural interests in the area.

4.5.3.2 Alternatives

Zero Alternative

Realisation of the Zero Alternative would lead to the area west of runway 1 remaining unexploited and in this way enable the preservation of objects of cultural value. This alternative would comply with Sigtuna municipality's goal concerning natural- and cultural environments stating that new development should accommodate current cultural values present in the developed landscape (Sigtuna Kommun, 2014a; b).

In summary: The overall assessment is that the Zero Alternative will have no notable impact on cultural heritage.

Alternative 1H (West)

This alternative would lead to the removal of most objects of cultural value identified in the study area. The village of Kättsta would be completely removed while some buildings of Kolsta village would be preserved. These buildings are however being used for services connected to the airport, such as a sportshall for security personnel and occupational education facilities, and are not included in the old farmhouses which are of cultural value.

In summary: The overall assessment is that Alternative 1H will have minor negative impacts on cultural heritage.

Alternative 1L (West)

The realisation of this alternative would enable the preservation of most cultural objects identified in the study area. It is however questionable how attractive this area will be for recreational purposes as the cargo- and warehouse section will be at the top part of Logistic City, which is where most of the cultural objects are located. Trucks and potential industrial activities could make the area unpleasant in terms of noise, dust, smell etc. which could affect the willingness of people to visit the areas where the cultural objects are located. The accessibility of the areas could also potentially be an issue due to their close proximity to activities involving heavy vehicles and industrial processes. However, both of these impacts are not notable since visitors will likely not access the area.

In summary: The overall assessment is that Alternative 1L will have no notable impact on cultural heritage.

Alternative 2H (South)

Same impacts as Alternative 1H concerning cultural aspects.

In summary: The overall assessment is that Alternative 2H will have minor negative impacts on cultural heritage.

Alternative 2L (South)

The realisation of this alternative would enhance the preservation of most cultural objects identified in the study area. The service facilities of Logistic City would be located in close proximity to the majority of the objects of cultural value, which could potentially have a positive effect on cultural aspects. By being so close to Arlanda airport, this area will most likely not attract a lot of visitors for recreational purposes which could lower the value of preserving these cultural objects today. However, with the development of service facilities such as hotels and restaurants, the number of people visiting the area could increase which in turn could potentially increase the value of these cultural objects as more people would be there to see and learn about them.

In summary: The overall assessment is that Alternative 2L will have minor positive impacts on cultural heritage.

4.5.3.3 Mitigation measures

Concerning cultural objects located in the areas where potential development is to take place, mitigation measures can be made in order to preserve and possibly even enhance the values of these objects. In the alternatives where the objects would be removed (high exploitation alternatives) there is the option of moving parts of the objects to alternative locations, such as exhibits or museums. Another alternative could be to use portions of the 20 % green spaces which are planned to be incorporated into the development, and create green spaces such as parks or gardens in the locations where these cultural objects are located. By doing so, and at the same time improving the accessibility to these areas, an enhancement of the value of the cultural objects could be achieved by incorporating them as an attraction in the urban development of the area. This would probably increase noticeability compared to the current situation where the accessibility for the general public is quite limited.

4.5.4 Hydrology

4.5.4.1 Baseline

The project site is located in the catchment of Märstaån, which includes most areas of Arlanda Airport. The proposed area of Logistic City and the area of Cargo City are located in two smaller sub-basins with separate flow systems: Kättstabäcken and Halmsjöbäcken (Figure 17). The two streams connect in Broby, carrying surface water southwest through Märstaån and eventually entering lake Mälaren. The area of Cargo City consists mainly of sand and gravel, with some patches of bedrock visible at surface level. The groundwater flows easily in fractured bedrock and coarse sediment. The proposed area of Logistic City is in general located on clay rich and fine grained sediments, which lower the hydraulic conductivity. Investigations made by SWECO VIAK indicate that the groundwater flows in a southwest direction, which in general follows the direction of surface water (Vatten och samhällsteknik AB, 2011). Water Balance components calculated by the Swedish Meteorological and Hydrological Institute show that for the watershed of Märstaån, average annual precipitation is 160 mm, evapotranspiration is 72 mm and total runoff is 44 mm.

Arlanda Airport has several systems for collecting storm water from significant areas, including the area of Cargo City. Storm water is led to specific ponds where it is treated and eventually discharged. Swedavia has an ongoing monitoring program that involves continuous measurements of oxygen levels, organic substances, phosphorus, nitrogen and metals in surface- and groundwater. In 2016, the water quality in Halmsjöbäcken was determined to be satisfactory (Swedavia airports, 2017c). However, it included increased values of arsenic, due to natural causes. For Kättstabäcken, the total amount of carbon was increased, due to drainage of organic material from surrounding forests and activities at the airport (Swedavia Airports, 2017c). Higher values of phosphorus and nitrogen have also been detected. Groundwater near Cargo City showed increased values of sulphate, chloride and potassium, which are partly from natural causes but also due to activities at the airport. Road salt is one of the main contaminants at Cargo City. Other contaminants are de-icing substances such as glycol. During the de-icing process only 10 % of the substances remain on the aircraft, 80 % - 90 % are collected and treated in ponds southwest of Cargo City and 1-10 % will eventually be collected as storm water or infiltrate through the drainage area.

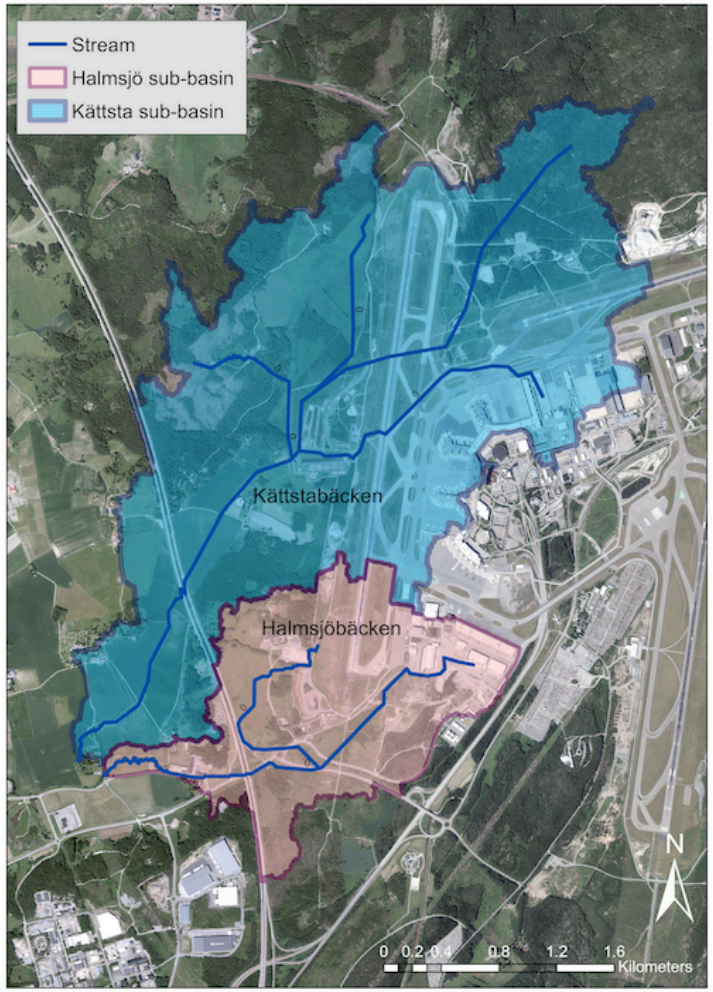


Figure 4.17. Map showing the sub-basins located in the project area together with its main streams.

4.5.4.2 Alternatives

Zero Alternative

The Zero Alternative will most likely have a minor negative impact. The area of the proposed activities in the west currently has little exploitation, with some smaller housing areas. However, there are ongoing farming activities in the surrounding area that may contribute to eutrophication, which affects nutrient and oxygen levels in streams and rivers.

Activities in the area of Cargo City are to some degree affecting the surrounding surface water, primarily due to the usage of road salt and de-icing substances. There is a risk of pollutants spreading from hard surfaces, especially during periods with high intensive rainfall. If no measurements are taken, future climate change, such as more rainfall, will most likely exceed the storm water capacity. This will result in local floods reaching the natural system and contaminating surface and groundwater. However, Swedavia is currently working on improving the storm water treatment system. There is a monitoring program and the results and actions are expected to be presented during 2017 (Swedavia Airports, 2017a). If further development of the storm water system occurs, the described impact on Märstaån is expected to decrease over time.

In summary: The overall assessment is that the Zero Alternative will have a minor negative impact due to the ongoing agricultural activities and current activities at the airport. If the current monitoring program will continue with positive outcome, the impacts on Märsta river will most likely decrease in the future.

Alternative 1H (West)

High exploitation in the west implies cutting down large forested areas. During the construction phase, clearance of land will decrease the holding capacity in soil and will therefore increase surface runoff and erosion. Runoff will also increase due to soil compaction through the use of heavy vehicles and equipment, which decreases the infiltration capacity. Construction work could also affect the local drainage and water courses, through excavation and cultivation. Runoff from construction activities will most likely have an impact on the water quality. Land vehicles used or stored on-site may leak fuel or oil, while other possible contaminants may come from building materials, unset cement, paint or other chemicals. Mitigation measures for the construction phase should be applied in order to prevent contaminants from spreading in surface water and eventually polluting Märstaån.

It will be important to increase the capacity of the current storm water system in order for it to hold for the expansion of Logistic City. The transaction between the construction phase and the operation phase is expected to be gradual. As more hard surfaces take form, storm water runoff will increase.

Increased traffic will generate more pollutants from for example vehicle emission, fuel and oil leakages, wear and tear of car components such as tires, breaks, frame and body as well as from the general wear of road surfaces. The rational method (Q=ciA) has been used to estimate peak discharge (Q) from drainage basin runoff. The model uses a runoff coefficient (c) based on soil type and drainage basin slop, together with the total area (A) and rainfall intensity (i). It is not a sophisticated model, but is useful to estimate trends in total runoff. Calculations using the rational method indicate that the surface runoff will increase by approximately 170 % compared to the amount of surface water that is generated if the same size of the area remains untouched. In order to determine the capacity of the storm water system, it is important to estimate in more detail how much runoff will increase due to change in land use, while also taking climate change into account. Increased runoff raises the potential of localised floods. If storm water is not collected and treated, contaminants from road salts and de-icing substances will leak into surface- and groundwater and cause severe impacts on ecosystem life in soil and rivers.

In summary: The overall assessment is that Alternative 1H will have a minor negative impact due to increases in surface runoff with risk of exceeding storm water capacity and leakage of contaminating substances. The major risks of contaminating surface- and groundwater are during the constructional and transition phases.

Alternative 1L (West)

Low exploitation in the west will result in similar impacts during the construction and operation phase as in alternative 1H, but in smaller scales. More of the forested areas will be preserved, which is positive for peak discharge management and the water quality. Nevertheless, the change of land use will still affect the water balance since higher peak flows are expected locally. Runoff calculations indicate an increase of approximately 180 % compared to if no constructions would take place in the area. The change between the construction phase and the operational phase is gradual, which implies that ongoing activities for the current location at Cargo City will gradually decrease and move towards the west. Therefore, the mentioned impacts from aircraft

management in alternative 1H are expected to also decrease in Halmsjö sub-basin and increase in Kättsta sub-basin. However, new areas of Arlanda Airport will most likely expand over the current area of Cargo City, making future impacts on the south area unclear.

In summary: The overall assessment is that Alternative 1L will have a minor negative impact due to increased surface runoff with risk of exceeding storm water capacity and leakage of contaminating substances. The magnitude of surface water runoff will be lesser compared to alternative 1H since more forest will be preserved.

Alternative 2H (South)

High exploitation in the west and south will have an effect on both the Kättsta sub-basin and the Halmsjö sub-basin with the mentioned impacts outlined in alternative 1H. The expansion of Cargo City in the south will affect the water balance and water course since more forested area will be clear cut and covered. Due to expansion in the south and also the construction of Logistic City, the sub-basin of Halmsjöån will be affected more compared to the other alternatives. The impacts will be similar to the ones mentioned in the other alternatives, such as contaminants spreading in surface water during the construction phase and also higher peak discharge during both construction and operation phases. Traffic generated pollutants would also increase to a smaller degree. An increase in surface runoff is expected for both sub-basins. Runoff calculations made for this alternative result in an increase in peak discharge of approximately 70 %.

In summary: The overall assessment is that Alternative 2H will have a minor negative impact due to increased surface runoff, especially for Halmsjö sub-basin, with risk of exceeding stormwater capacity and leakage of contaminating substances.

Alternative 2L (South)

Low exploitation in the south will have the least impact on hydrological dynamics in the watershed. Most forested areas are avoided and remain untouched both in the west and in the south. No construction work is needed in the area of Cargo City since the area remains the same. The main impacts will origin from the construction work at Logistic City in the west. Minor impacts on the watershed are still expected due to the expansion of hard surfaces in the west. The peak discharge is calculated to increase with approximately 80 % for this alternative.

In summary: The overall assessment is that Alternative 2L will have the least impact on water quality and course. The impact is still assessed to be minor negative due to increase surface runoff and leakage of contaminating substances, especially during the construction of Logistic City.

4.5.4.3 Mitigation measures

The following mitigation measures are suggested to be applied for all alternatives, but with varying magnitude depending on the scale of the project. Initially, a construction- and water management plan should be outlined. The assessed potential impacts during the construction phase of the project would require that runoff in the area are collected and managed in a way so that no contaminated water is discharged into the watercourses. To reduce the risk of local flooding due to the assessed increase in runoff, drainage channels and ditches should be installed along all temporary roads and constructions. Localized pumping may also be required for some cases. It is strongly suggested that material and equipment that has a risk of leaking contaminating substances, such as fuel and oil, should be stored as far away as possible from drainage ditches and watercourses.

In preparation for the actual operation phase it is important to outline a monitoring plan for surface- and groundwater. Soil and water analysis tools can be used to estimate and predict the effects of land use change on surface runoff, infiltration and peak flow in order to avoid the risk of exceeding the capacity of the storm water systems. A monitoring plan should be developed and followed when the operation is in action, including continuous measurements of surface- and groundwater quality and levels. This is to see ongoing trends and changes in hydrology, so that negative changes may be further mitigated before severe impacts occur.

4.5.5 Traffic and transport

4.5.5.1 Baseline

The E4 highway going between Stockholm and Uppsala lies one kilometre from the current Cargo City and just west of the area planned for the development of Logistic City. The E4 is connected with Cargo City by two roads. One is Fraktvägen that is open for common traffic and frequented by a number of public transport buses during day and night. West of that lies Cargo Cityvägen that is reserved for authorized vehicles. There are a couple of walking and bicycle paths in the area. One of them, following Fraktvägen, is part of a regional bike route connecting Arlanda airport with Märsta (Sigtuna Kommun, 2014c). The railway Arlandabanan goes right under Cargo City. The closest station is Arlanda Station by the airport terminals a few hundred meters north. Another railway, Ostkustbanan, is located a few kilometres west of the Logistic City area and the E4.

Road 273, going just east of Cargo City, and both the railways are of national interest (Sigtuna Kommun, 2006). The E4 and the exit road E4.65 that proceeds into road 273 are also assigned primary routes for hazardous cargo by the county administrative board; petroleum products as well as other hazardous cargo will be transported on these roads (Sigtuna Kommun, 2006). Owing to this it is recommended to keep a 25-meter-wide zone along these roads free of structures, as well as a 75 meters' zone free from personnel intensive activities (Sigtuna Kommun, 2006). Since 2006, the jet fuel used at the airport is transported through underground pipelines to the fuel depot in Cargo City (Sveriges radio, 2006).

With regard to cargo traffic we have made a rough calculation of the number of cargo trucks going to Cargo City today based on the assumption that a heavy truck has a 26 tonnes cargo capacity (Tennessee-Tombigbee Waterway, n.d.). A yearly cargo volume of 200 000 tonnes generates approximately 7 700 trucks per year or 20 per day. Since every truck goes both in and out of the area, this means on average 40 truck drives per day on any of the two roads going into Cargo City. This could be higher or lower depending on truck sizes, usage of truck trailers and whether the trucks are loaded to full capacity. It could also be lower if some cargo is transported with railway.

4.5.5.2 Alternatives

Zero Alternative

Traffic is increasing even if no new development is carried out since the air cargo increases until the maximum capacity of today's Cargo City is reached. However, the increase will not be significant.

In summary: The overall assessment is that the Zero Alternative will have no notable impact since traffic increase is not significant.

Alternative 1H (West)

The alternative will generate new traffic to the area which goes against the national goals of decreasing car traffic and not increasing truck traffic. With a new industrial railroad track, this alternative may make it possible to load air cargo directly to a train instead of trucks. The proximity between the areas for cargo and logistics can also simplify coordination of transport. On the other hand, Cargo City is located on the other side of runway 1 from the terminals in this alternative as well as in Alternative 1L. This causes an increased cargo transportation distance between these places.

Most part of the area is located far away from current bus lines, making the public transport system less attractive. Busses would not be able to pass through the area, but would have to go into the area and then turn around and go back the same way. The large exploitation of the area might still justify such a solution.

With the high scenario of cargo amount, the number of trucks would likely be about five times higher than today. This means that almost 38 500 trucks per year would go in and out of Cargo City, and about 200 heavy truck movements per day, or 8 per hour if calculated on a 24-hour basis, would pass through the northern part of Logistic City.

In summary: The overall assessment is that Alternative 1H will have a minor negative impact since traffic is expected to increase.

Alternative 1L (West)

The alternative will give a slight increase in traffic. Similar to Alternative 1H, this alternative may give the opportunity to coordinate traffic and increase transportation by train. The lesser exploitation might not justify a new or changed bus line.

With the low scenario of cargo amount, the number of trucks would likely be about three times higher than today. This means that about 23

000 trucks per year would go in and out of Cargo City, and about 120 heavy trucks per day would pass through the Logistic City service area.

In summary: The overall assessment is that Alternative 1L will have a minor negative impact since traffic is expected to increase.

Alternative 2H (South)

The alternative will generate more traffic to the area. Expanding the cargo area in the south might make the cycle path less attractive, although it is probably not very attractive as it is today since it already passes next to the cargo area. It could also be a good opportunity to improve the bike path as part of the project, for example by straightening it and making the road crossing simpler. Cargo City will be close to already existing bus stops, but the north part of Logistic City would still be far away from the public transport system.

The approximately 200 heavy truck movements per day would in this scenario pass through to Cargo City on the roads going south of the runway. It is possible in this scenario that enlargements of these roads may be needed if the future traffic is very concentrated in time.

In summary: The overall assessment is that Alternative 2H will have a minor negative impact since traffic is expected to increase.

Alternative 2L (South)

The alternative gives a slight increase in traffic. The movements of approximately 120 heavy trucks per day would in this scenario pass through to Cargo City on the roads going south of the runway. Though the numbers are not as high as in 2H, it is possible that enlargements of these roads are needed in this scenario as well.

In summary: The overall assessment is that Alternative 2L will have a minor negative impact since traffic is expected to increase.

4.5.5.3 Mitigation measures

One way of relieving the traffic situation is to expand the existing roads, this would also generate new traffic which has a negative effect on climate. One way of rounding this could be to make roads only for certain types of traffic, such as buses and trucks. Other ways of alleviating increases in traffic include better access to public transport and transporting cargo by a rail system. An improved bicycle road system could also allow employees of Arlanda better access to their work sites while relieving traffic. The issue with increased cargo transports in Alternatives 1H and 1L could potentially be solved by building a tunnel under the runway, an idea mentioned by the cargo manager.

4.5.6 Noise

4.5.6.1 Baseline

Since the logistic zones are planned near one of the airport's runways, noise levels are of obvious concern. A measure of noise levels around Arlanda was carried out in 2011 by a Swedavia consultant (Trafikverket, 2011). The levels are measured in L_{den}, the common EU noise measurement, which shows the 24h average noise levels in dB with added "penalties" of +5 dB during evening and +10 dB during night (European Environment Agency, 2010).

In the current Cargo City area, measured levels were L_{den} 55-60 dB, with a small part reaching 60-65 dB. The proposed area for an expansion southwards of Cargo City along road 273 has roughly the same conditions with most of the area between L_{den} 60-65 dB. The location of the possible replacement of air cargo west of runway 1 lies mostly inside L_{den} 60-65 dB, but a stretch closest to the runway inside 65-70 dB. Swedavia's proposed area for Logistic City is all outside of the L_{den} 65 dB-boundary. Most of it lies inside 55-60 dB, but the north-western part is only inside 50-55 dB (Trafikverket, 2011). Additionally, a map of noise levels from road traffic shows that the westernmost part of the expansion area for the western alternative (close to the E4) is affected by noise levels above L_{den} 55 dBA (Trafikverket, 2011).

4.5.6.2 Alternatives

Zero Alternative

A realisation of the Zero Alternative would mean that an increased noise level due to construction and operation phases of the proposed project would not occur. This would mean that the noise level at the location of Cargo City would remain the same as today (within L_{den} 55-60 dB).

In summary: The overall assessment is that the Zero Alternative will have no notable impact.

Alternative 1H (West)

When adding noise from different sources together, if the level difference between the two sources is big enough (>10 dB), the perceived noise will equal that from the louder source (NoiseNet, n.d.). For added noise in the area, it consequently has to be louder than 45-60 dB (depending on the differences within the area today) to cause changed conditions. When adding levels together, the addition to the louder level is 1-3 dB (NoiseNet, n.d.). As some examples of guideline values, noise from construction sites should not be above L_{den} 70 dB outside office buildings (Naturvårdsverket, 2017a), and traffic noise should not be above 55 dB on a daily average at house facades (Naturvårdsverket, 2017b).

During the construction phase, usual noise levels for some typical activities (formworks, frameworks and operation of heavy equipment) are at around 90-95 dB (Elcosh, 2003). These are the levels at the

source, and the decrease with distance is approximately 6 dB per every doubling of distance length (NoiseNet, n.d.). As calculated with a sound level estimating resource (Hyperphysics, n.d.), 95 dB at the sound source would give a level of 55 dB on a distance of a hundred meters. This means that construction work noise should influence the general noise levels only 50-100 meters from the construction site in the loudest part of the area, where the new Cargo City is proposed. In the relatively quieter western parts of the area, construction works at a longer distance, up to around 200-300 metres, could add to the noise levels. Because the designated area is large enough for construction noise to dissolve beyond impact in most of the area, the actual impacts during a constructional phase depend on construction patterns. Since there is little activity in the area now, nuisance during constructions would likely affect mainly those facilities completed earliest in the development.

As for the operational phase, activities in the area that possibly could create noise are new traffic, cargo handling and perhaps some sort of industries. A single medium- or heavy weight truck can create noise above 75 dB on a distance of 2-5 meters (Björkman & Rylander, 1997), and noise from a line source (such as a road) also decreases less with distance, giving only a 3 dB decrease with doubling of distance (NoiseNet, n.d.). Noise levels might thus be increased along roads going through the area up to a few hundred meters away. With two exits from the E4, this is probably most apparent in the northern part, where the cargo handling and related facilities should be located, with a presumed higher amount of heavy traffic. Parts of the development, such as hotels and offices, could thereby be excluded from much of the traffic noise.

For the cargo handling part, on the baseline noise mapping around Arlanda (Trafikverket, 2011) the existing Cargo City does not seem to affect the general surrounding noise levels. Because the proposed westerly Cargo City-location is even closer to the runway, it is unlikely that its effect would be noticeable. Other future activities in the area (e.g. light industries) are unknown and might create some noise depending on type.

However, while the aircraft noise in the area is probably an average based on relatively high variations in levels, the impacts from both constructional and operational noise could be more significant if they stay at a steadier level. On the other hand, the calculations of noise levels with distance are assuming "perfect" sound propagation. In reality the sound distribution depends on the surroundings, for example "soft grounds" such as grasslands or fields absorb more sound on the way than paved surfaces (NoiseNet, n.d.).

Lastly, it should be noted that future increased air traffic (which would follow from an additional runway and increases in both passenger traffic and cargo flights) certainly has a considerably larger effect on the noise levels than the activities inside the logistic areas. That factor is however outside the system boundaries of this section.

In summary: The overall assessment is that Alternative 1H will have minor negative impacts on noise levels during construction works and also due to traffic, depending on the planning in the area.

Alternative 1L (West)

A difference in this alternative, relative to 1H, is that the southern and northern parts of Logistic City are divided, which can create a sound barrier between the two parts. On the other hand, with only one exit from E4, heavy traffic will have to pass through the service area of Logistic City.

In summary: The overall assessment is that Alternative 1L will have minor negative impacts on noise levels, mainly since heavy cargo traffic might not be separated from the service area.

Alternative 2H (South)

This alternative differs from 1H in that Cargo- and Logistic City are built separated, thus construction works in one of the areas would not impact the other. It is unlikely that construction works, or any other noise, in Cargo City would cause nuisance in the surroundings, since there is some distance to the nearest other facilities. Perhaps an expansion of the terminals being made southwards could change this. There would be less heavy traffic in Logistic City, and instead more south of the runway, but there are currently no activities to be disturbed there.

In summary: The overall assessment is that Alternative 2H will have minor negative impacts on noise levels, mainly during the construction phase of Logistic City.

Alternative 2L (South)

Differs from Alternative 2H in that the southern and northern parts of Logistic City are divided (as Alternative 1L), and that some more traffic will pass through the Logistic City "business" area.

In summary: The overall assessment is that Alternative 2L will have no notable impacts since finished facilities could be separated from construction sites and the heavy cargo traffic is kept outside the service area in Logistic City.

4.5.6.3 Mitigation measures

An initial way to minimize noise impact would be to plan the area in a way that puts noise emitting activities at a distance from noise sensitive facilities. This could be done by either space of "soft ground" in between, or perhaps by screening off a more noise sensitive facility with one that is less so. With a relatively large amount of green space in the developed area of all the proposed alternatives, it should be possible to plan in a way that causes minimal nuisance from traffic noise in most buildings.

Planting bushes and trees in and around sound generating sources is another solution that has shown to mitigate noise pollution (Peng *et al.*, 2014). For instance, a natural extending of the arboreal coverage along the runway could also work as a noise barrier. However, the effectiveness of vegetation as a noise barrier is debated, and for instance Trafikverket (2016a) claim that it is not a certainly functioning measure. Their methods instead include noise screens along certain roads together with soundproofing components (windows, ventilators etc.) on buildings (Trafikverket, 2016b).

4.5.7 Air quality and Climate

4.5.7.1 Baseline

Modelled maps from SLB analysis show that levels of both PM10 and NO_2 are within the environmental norms and goals. The norms are only exceeded on the E4 and E4.65, but the levels drop quickly with the distance from the road (Stockholms stad, 2017). Maps are not available for PM2.5. The concentrations are calculated with a model that does not include emissions from aircraft, meaning the levels around the airport are underestimated. The environmental report of Arlanda states that air quality standards are only exceeded for tropospheric ozone, owing to the high background levels in the Stockholm region (Swedavia Airports, 2017c). There may be large emissions of ultrafine particles (UFP) when a plane takes off, causing peaks of high concentration downwind of the airplane (Zhu *et al.,* 2011). Because of their small size (in the nanometer range), the particles have very little mass even though they are very numerous. There are today no quality standards for UFPs and thus no regular measurements are made.

Swedavia uses "green" energy and electricity for all of its buildings at Arlanda airport, meaning that most of the airport's own emissions are coming from transport. Swedavia's own vehicles emitted around 1000 tonnes of CO_2 in 2016, with a total of 2600 tonnes when including vehicles from external companies refuelling at the airport (Swedavia Airports, 2017c).

4.5.7.2 Alternatives

Zero Alternative

Air pollution levels are likely to increase even if no new development is carried out in the area, since the traffic will still increase. Pollution levels are still highest in the road areas and no new buildings are constructed in areas exposed to high levels of pollution.

Greenhouse gas emissions may increase with increased air cargo, until the maximum capacity is reached. At the same time Swedavia has a goal of reducing its own emissions to zero by the year 2020. There is also an ongoing project with electrified transport from the airport's cargo area to Rosersberg logistic area. If these projects are successful, the freight related GHG emissions can decrease in the Zero Alternative.

In summary: The overall assessment is that the Zero Alternative will have a minor negative impact due to current and future vehicle emissions.

Alternative 1H (West)

The realisation of Alternative 1H will increase the amount of heavy traffic, which in turn will lead to an increase in particle emissions. Particle levels may be quite high if the service part of the area is built with high buildings and narrow streets, however this is not likely owing to height restrictions around the airport. There is a risk of high levels of UFP when the wind is blowing towards the area. The south part of the area, with services, may be more exposed as it is close to the direction of the exhaust plume when an aircraft takes off in a northerly direction.

Conversely, the cargo area is less exposed as it is located perpendicular to the exhaust plume.

The extra traffic generated, by the new exploitation and by the new motorway ramps, will contribute to increased GHG emissions. Co-locating the cargo and logistic zones gives the opportunity to move more freight transport from roads to railroad if an industrial track is built to the area.

In summary: The overall assessment is that Alternative 1H will have a minor negative impact due to increased traffic and vehicle emissions.

Alternative 1L (West)

This alternative gives a smaller increase in particle emissions. Similar to the previous alternative, there is a risk of high levels of UFP when the wind is blowing towards the area.

The extra traffic generated will lead to more GHG emissions, but to a lesser extent than in Alternative 1H. Co-locating the cargo and logistic zones gives the opportunity to move more freight transport from roads to railroad if an industrial track is built to the area.

In summary: The overall assessment is that Alternative 1L will have a minor negative impact due to increased traffic and vehicle emissions.

Alternative 2H (South)

The alternative will increase the amount of heavy traffic leading to an increased particle concentration. Traffic going to and from Cargo City does not have to pass inside the service area, so the increase in particle concentration is dampened a bit. There is a risk of high levels of UFP when the wind is blowing towards the area. The south part of the area may be more exposed as it is close to the direction of the exhaust plume when an aircraft takes off in a northerly direction. This includes parts of both the logistic area and the cargo area.

The extra traffic generated will contribute to additional GHG emissions. A more fragmented cargo and logistic area makes co-transport and railroad transport more difficult.

In summary: The overall assessment is that Alternative 2H will have a minor negative impact due to increased traffic and vehicle emissions.

Alternative 2L (South)

This alternative gives a smaller increase in particle emissions. As with earlier alternatives, there is a risk of high levels of UFP when the wind is blowing towards the area - especially in the south parts. This includes parts of both the logistic area and the cargo area, although the smaller cargo area is not as much exposed as in alternative 2H.

The extra traffic generated will contribute to additional GHG emission, but less so compared to Alternative 2H. A more fragmented cargo and logistic area makes co-transport and railroad transport more difficult.

In summary: The overall assessment is that Alternative 2L will have a minor negative impact due to increased traffic and vehicle emissions.

4.5.7.3 Mitigation measures

Dust binding can be used on roads where there is a risk of breaching air quality standards. This would mainly be in question for the E4 where it is passing close by Logistic City. It could also be used on some main roads inside the area on days with a risk of high particle levels. As mentioned earlier, the structure of the buildings also affects the air quality - with narrow street canyons trapping the pollutants between the buildings. This kind of streetscape should be avoided in cases where large amounts of heavy traffic is expected. Physical barriers can also be installed to deflect pollution from outside the area - this can also have a positive effect on noise.

Traffic is a source of aerosol particles and also contributes to greenhouse gas emissions, so limiting motorised road traffic would have a positive effect on these factors. Mitigation measures regarding traffic are discussed in section 4.5.5.3.

Using building materials and methods that require less energy can be effective in reducing the impact on climate in the construction phase. This can also make the buildings more energy efficient in the operation phase – especially the warehouses which in some cases need extensive cooling. The large roofs of the warehouses would be suitable for solar panels. There are however restrictions regarding reflective surfaces close to the airport (Sigtuna Kommun, 2006), so it might not be possible to find suitable panels with today's technology. This should not be discouraging since less reflecting panels could be developed in the future.

4.5.8 Socio-economic Impacts

4.5.8.1 Baseline

Arlanda Airport is both a direct and indirect employer, housing around 600 different companies which together employ about 17,500 people (Swedavia Airports, 2017c). In addition to this there are 880 people who are employed by the organization of Arlanda (ibid). It is reported that about 24.7 million travellers visited the airport in 2016 (ibid) and Swedavia aims to increase this number drastically over the coming decades, meaning a need for facility expansion and development. These initiatives will undoubtedly lead to a vast amount of new employment opportunities within Sigtuna municipality.

A 2014 study assessed Sweden's air travel industry and found that more than 130 billion Swedish kronor are added to Sweden's GDP each year (Swedavia Airports, 2016). Total employment of all airports in Sweden is estimated at 180,000 jobs, with a potential for 20,000 new jobs created in the next five years as international air travel expands (ibid 2016). Other sectors also benefit from the access that air travel provides; about 100,000 jobs exist as a result (ibid).

If Swedavia's projected increase in cargo by 2070 is realised facilities will need to expand its facilities in order to handle such a volume. It may be noted in this context that prognostication on a 50-year time scale is

highly uncertain and the margin for error is very large indeed. Sigtuna municipality recognizes the potential for future development within its Oversight Plan. There, the municipality stresses the importance of concentrating development in its neighborhoods, especially in Märsta and the Arlanda-Märsta area (Sigtuna Kommun, 2014a). This will improve access to services around Arlanda Airport City, likely increasing revenue for surrounding businesses. It will also strengthen the municipality's vision to maintain and strengthen trade and industry, which are dominated by logistics and tourism (Sigtuna Kommun, 2014a). At the same time, there are some trade-offs between economic growth and public health, since construction and operation of additional developments affect air quality, landscape, and stress levels.

4.5.8.2 Alternatives

Zero Alternative

If Arlanda remains as it is today with no expansion or development of Cargo City and Logistic City, the airport will be unable to handle the increase in cargo expected in the coming years. Swedavia will also lose out on profit from renting out additional warehouse and retail space beyond what is currently leased in Cargo City. There will also be limited job growth within the logistics sector in Sigtuna municipality, assuming that Logistics City becomes a major hub for such operations and services which it undoubtedly will. As a result, there will be limited potential for the Arlanda-Märsta area to expand in connectivity and accessibility to the west of runway 1.

In summary: The overall assessment is that the Zero Alternative will have a major negative impact on the municipality's goal to develop the Arlanda-Märsta region.

Alternative 1H (West)

In this alternative, development of Cargo City and Logistic City are maximized. For Logistic City, this means an area of about 130 ha can be utilized for warehouses, offices, parking, roads, office buildings, shopping malls, and green spaces. Job opportunities will be at their highest, providing immense economic benefits to Sigtuna, increasing the number of people that can both work and live within the municipality. Swedavia will increase their profit by renting out warehouses and other facilities to various businesses. The planned cargo and logistic space will also support and facilitate a steady growth in Sweden's air travel industry, contributing to an increase in the country's GDP. The construction phase in this alternative is likely to be costly and require huge investment, especially in relocating Cargo City to the west of runway 1. Swedavia already owns the land, which alleviates some of the costs.

The proposed area in this alternative also avoids an existing career education centre and sports hall, ensuring the preservation of any ongoing economic activity. The only potential losses are a few scattered buildings and yards, such as those in Kättsta as well as the potential for worsened air quality due to increases in traffic and loss of aesthetic values in the landscape, potentially affecting people's health. Due to the current use of the land and expected benefits of development, economic benefits will likely exceed any costs.

In summary: The overall assessment is that Alternative 1H will have a major positive impact on the municipality's goal to develop the Arlanda-Märsta region.

Alternative 1L (West)

In this alternative, the amount of land used for Logistic City is 70 ha, about half of the land used in the high exploitation alternative. There is still opportunity for economic growth, but not to the same extent as the high exploitation alternative. As in the previous alternative, relocating Cargo City to the west of runway 1 is another potential cost to consider. Due to the smaller scale of the development, both investment costs and maximum socioeconomic benefits will generally be less in comparison to the previous alternative but still significant to the region.

In summary: The overall assessment is that Alternative 1L will have a major positive impact on the municipality's goal to develop the Arlanda-Märsta region.

Alternative 2H (South)

The impacts are the same as those listed for Alternative 1H in regards to Logistic City, except for the fact that there would be an additional 10 ha of land available for development due to the placement of Cargo City in the south. Keeping Cargo City in the south will likely decrease costs since the air cargo terminal will not need to be relocated. However, the existing cargo area might need to be restructured in order to improve efficiency so that additional cargo handling and storage area can be built. As in the previous alternatives, there is the potential for worsened air quality due to increases in traffic and loss of aesthetic values in the landscape. However, this is not deemed significant in light of expected benefits.

In summary: The overall assessment is that Alternative 2H will have a major positive impact on the municipality's goal to develop the Arlanda-Märsta region.

Alternative 2L (South)

The impacts are the same as those listed for Alternative 1L in regards to Logistic City. Since Cargo City does not expand in total land area in this alternative, development is limited. In order to be able to handle an increase in cargo, the existing area might need to be restructured in order to increase efficiency. This may prove difficult due to existing infrastructure. Also, freight companies will have less space to expand their operations in close proximity to the existing air cargo terminal. However, expected economic growth and the prospect of improving efficiency within the cargo area outweigh these considerations.

In summary: The overall assessment is that Alternative 1H will have a major positive impact on the municipality's goal to develop the Arlanda-Märsta region.

4.6. Summary of Environmental Impact Assessment

4.6.1 Impact Matrix Assessment

The impact matrix (Table 4.6) shows the five different alternatives and their respective impacts on the identified environmental categories. The matrix has a five-graded scale ranging from major positive impact to major negative impact.

Table 4.6. Impact Matrix Assessment.

Environmental Impacts	Zero Alternative	Alternative 1H	Alternative 1L	Alternative 2H	Alternative 2L
Landscape and Ecology	**No notable impact.**	**Major negative impact** due to high urbanization of the landscape, affecting areas with high natural value.	**Minor negative impact** due to considerable urbanization with some safeguarding of existing landscape including areas with high natural value.	**Major negative impact** due to high urbanization of the landscape, affecting areas with high natural value.	**Minor negative impact** due to considerable urbanization with some safeguarding of existing landscape including areas with high natural value.
Biodiversity	**Minor negative impact** due to current noise disturbance for fauna and habitat fragmentation.	**Major negative impact** due to total destruction of four natural areas causing habitat loss and fragmentation. Increases in noise and light pollution.	**Minor negative impact** due to landscape fragmentation and loss of connectivity. Increases in noise and light pollution.	**Major negative impact** on due to total destruction of three natural areas causing habitat loss and fragmentation. Increases in noise and light pollution.	**Minor positive impact** if connectivity is improved between natural areas. **Minor negative impact** due to landscape fragmentation and loss of connectivity. Increases in noise and light pollution.

Cultural Heritage	**No notable impact.**	**Minor negative impact** due to removal of most objects of cultural value.	**No notable impact.**	**Minor negative impact** due to removal of most objects of cultural value.	**Minor positive impact** due to increase in people, potential for incorporating cultural objects into development making them more accessible for the general public.
Hydrology	**Minor negative impact** due to release of nitrogen and phosphorus from agriculture. Use of road salt & de-icing substances contaminating surface water.	**Minor negative impact** due to increase surface runoff with risk of exceeding storm water capacity and leakage of contaminating substances.	**Minor negative impact** due to increased surface runoff with risk of exceeding storm water capacity and leakage of contaminating substances.	**Minor negative impact** due to increased surface runoff, especially for Halmsjö sub-basin, with risk of exceeding storm water capacity and leakage of contaminating substances.	**Minor negative impact** due to increase surface runoff with risk of exceeding storm water capacity and leakage of contaminating substances.
Traffic and Transport	**No notable impact.**	**Minor negative impact** due to increased traffic and poor access to public transport.	**Minor negative impact** due to increased traffic and poor access to public transport.	**Minor negative impact** due to increased traffic and poor access to public transport.	**Minor negative impact** due to increased traffic and poor access to public transport.
Noise	**No notable impact.**	**Minor negative impact** due to construction works and new roads/traffic.	**Minor negative impact** mainly due to new traffic.	**Minor negative impact** mainly due to construction works.	**No notable impact.**

Air Quality and Climate	**Minor negative impact** due to current vehicle emissions.	**Minor negative impact** due to increased traffic and vehicle emissions. Should not exceed thresholds.	**Minor negative impact** due to increased traffic and vehicle emissions. Should not exceed thresholds.	**Minor negative impact** due to increased traffic and vehicle emissions. Should not exceed thresholds.	**Minor negative impact** due to increased traffic and vehicle emissions. Should not exceed thresholds.
Socioeconomic Impacts	**Major negative impact** due to projected lack of capacity for future cargo needs, limited employment opportunities. Potential revenue is non-existent.	**Major positive impact** due to significant increases in cargo capacity, employment opportunities, and revenue.	**Major positive impact** due to increases in cargo capacity, employment opportunities, and revenue.	**Major positive impact** due to significant increases in cargo capacity, employment opportunities, and revenue.	**Major positive impact** due to increases in cargo capacity, employment opportunities, and revenue.

4.6.2 Flow Diagram

The flow diagram below (Figure 4.18) explores the flow of activities and impacts arising during the development and expansion of Logistic City and Cargo City at Arlanda Airport.

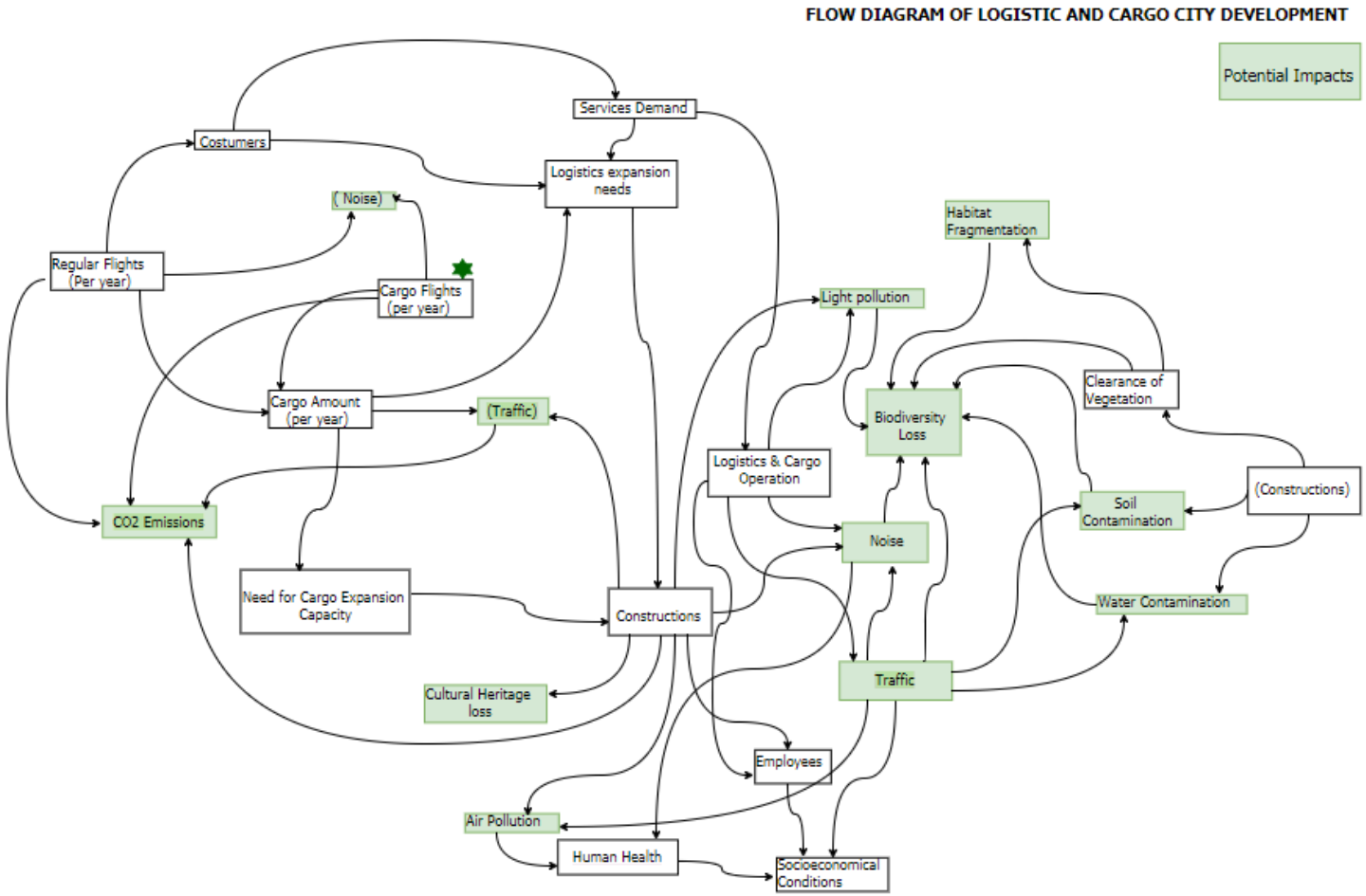


Figure 4.18. Flow diagram of the development of Logistic- and Cargo City.

4.7. Discussion

In any project, the scale of development should correspond to a realistic need for services and facilities. A lower scale of development has the potential to further expand in the future along with possible increases in demand. Any projections 50 years into the future ought to be treated with great caution. However, they may be useful for informing developers about expected spatial needs as well as for facilitating discussions with different stakeholders. Perhaps the biggest finding in our EIA is that efficiency plays a crucial role in determining the scale of impacts, since a high efficiency will lead to less space needed for cargo handling. This highlights the importance of considering efficiency early in the planning process.

Based on the final overall assessment, the alternative we recommend concerning the future development of Logistic- and Cargo City is Alternative 2L. This alternative will have the least negative impact on the surrounding environment and even has the potential to have positive impacts on certain aspects, such as biodiversity and cultural heritage, as well as socio-economic factors. The main factor bringing about positive impacts in Alternative 2L, in comparison to its low exploitation counterpart of Alternative 1L, is the ability to place Logistic City 1 (services area) in the northern part of the development as well as having an open space in between runway 1 and Logistic City. This open area enables the possibility to create ecological corridors, which would bring about significant benefits for biodiversity. The influx of people – a result of the services provided – to Logistic City 1 would increase the possibilities of designing the area with a focus on green spaces and incorporating both natural- and cultural values into the development.

Another difference between the two low exploitation alternatives relates to noise. Noise would be slightly less in the Logistic City of Alternative 2L since heavy cargo traffic is kept separate from the services area.

Logistic City 1 is not located at the upper portion of Logistic City in Alternative 1L because Cargo City will be located adjacent to this area meaning that the heavy logistical activities, i.e. those in Logistic City 2, need to be located here as well. This means that there is less potential to increase accessibility to existing cultural values since the area will not be open to the general public. However, this alternative may have a logistical advantage not assessed within our impact matrix. This is that Cargo City and Logistic City 2 would border each other, meaning that freight handlers can expand their warehouses and logistics in close proximity to the Air Cargo terminal.

As mentioned in the traffic and transport-section, if Cargo City would be moved to the west side it would possibly be beneficial to construct a tunnel under the runway to the terminals. This would be to avoid long transportations of cargo around the runway when it is to be loaded "pax-belly" (in regular passenger planes). This project could bring on additional impacts in our alternatives 1H and 1L, as well as significant costs for the developer. However, impacts from a potential tunnel is not assessed in the report since it is uncertain how likely it is to actually be constructed if Cargo City would be moved.

In the chosen alternative (Alternative 2L), there is a longer distance between Logistic City 2 and Cargo City in comparison to Alternatives 1H

and 1L, where Cargo City is located right next to Logistic City. However, retaining the existing Cargo City in the south as our chosen alternative suggests means that the Air Cargo terminal would not need to be relocated, perhaps reducing costs.

Urbanisation is an inevitable consequence of the development of Logistic- and Cargo City. This in turn leads to an irreversible loss of natural habitats, which is the main negative impact on landscape and biodiversity in this area. Even when applying mitigation measures, negative impacts on the landscape and biodiversity will occur, which is something to consider in most projects involving major development of an unexploited area (Gaworecki, 2016). Here, decision makers must weigh the benefits of the proposed development against the negative impacts on the environment in order to make the most sustainable decision concerning environmental, economic and social aspects alike (Fegler & Unemo, 2000). In order to understand the functionality of ecological corridors as a mitigation measure within Logistic City and Cargo City, a monitoring plan is recommended.

Similar to loss of natural habitats, the increased surface runoff from an increased amount of hard surfaces and contamination of surface- and groundwater during construction are inevitable impacts on water bodies when conducting this kind of project. GHG emissions and air pollutants are also generated by the increased traffic and operation of machinery during the construction phase. Constructing and operating cargo and logistic facilities will contribute to noise and light pollution, in addition to the risk of diminishing cultural value by changing the existing landscape. In this development, the impact will be minor since there is little to no public use of the cultural areas today. Perhaps the biggest benefits of developing Logistic City are the expected increase in cargo capacity, jobs, and economic growth. Developing the area agrees with Sigtuna municipality's vision to strengthen the region's industry.

In our consideration of Alternative 2L as the best alternative for this development, we suggest implementing the following mitigation measures:

- Ecological corridors to ensure ecological connectivity
- Warm, directed light during construction and operation phases to respect nocturnal species
- A construction and water management plan as well as drainage channels and ditches during construction phase
- Dust binding on roads and physical barriers to deflect pollution
- Using building materials and methods that require less energy
- Planning the area in a way that puts noise sensitive facilities at some distance from noise sources
- Incorporating cultural values into the development and design

There is significant uncertainty when assessing the different alternatives owing to the difficulty to decide the importance of the identified impacts relative to one another. Since a significant part of this EIA has been concerned with the scale of the project, the identified impacts have largely been the same, but in varying degrees. However, it is important to note that there is no weighting system in place to determine how much each impact should be valued.

Some further uncertainties remain regarding the likelihood of constructing a tunnel under the runway, changes in traffic flows, and the role of technical and societal changes. For instance, the impact of traffic on air quality and GHG-emissions largely depends on the shift away from fossil fuels, and the need for cargo facilities and related

services (which controls the required scale of development) in the future is highly unknown.

4.8. Conclusion

The development of the new Logistic- and Cargo City will have impacts on the local landscape and ecology, biodiversity, hydrology, air quality, noise, cultural heritage and socioeconomic conditions. Most of the impacts are negative to some extent (either minor or major), but there are also positive impacts that can be achieved, most of which would result from the development of Alternative 2L. Therefore, the recommendation from the authors of this EIS is to develop Logistic- and Cargo City according to Alternative 2L. This would mean that keeping Cargo City in its current location is (for environmental reasons) favourable over replacing it west of runway 1.

Also, developing a high efficiency in the cargo handling is vital for keeping the space demand low. A smaller scale development with a higher efficiency degree is recommended because it causes somewhat less significant impacts but still provides sufficient space for necessary activities and facilities which would make up Logistic City (see Figure 4.4). Moreover, the future need for logistics and related facilities is uncertain, justifying the strategy of beginning with small-scale development with a possibility of future expansion if the demand were to increase.

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4.10 Appendices

Appendix I: Questions from interview with Cargo Manager
Appendix II: Maps Showing Alternatives
Appendix III: Flow Diagram with Detailed Description
Appendix IV: Photos of Project Area

4.10.1 Appendix I: Questions from Interview with Cargo Manager

Interview with Bas Van Goch, Cargo Operations Manager at Arlanda Airport.

- What would be the use of Logistics City? What do you want the development to include?
- Why this specific area (west of runway 1), and what is the purpose of merging cargo/business with hotels and service areas?
- What is the difference between Cargo City and Logistic City 2?
- What do the current logistics look like for Arlanda? Do they occur at Cargo City now?
- Does Swedavia own the property for the proposed sites? What about the existing buildings, village, and farm areas?
- Is it an alternative to move only parts of Cargo City west of the runway?
- If Cargo City is moved to the west of the runway, will that make cargo transports at the airport problematic?
- Is it an alternative to place parts of this development on the other side (east) of the E4?

4.10.2 Appendix II: Maps Showing Alternatives

Large-scale maps of the alternatives studied in the report can be found on the following pages

Alternative 1 High



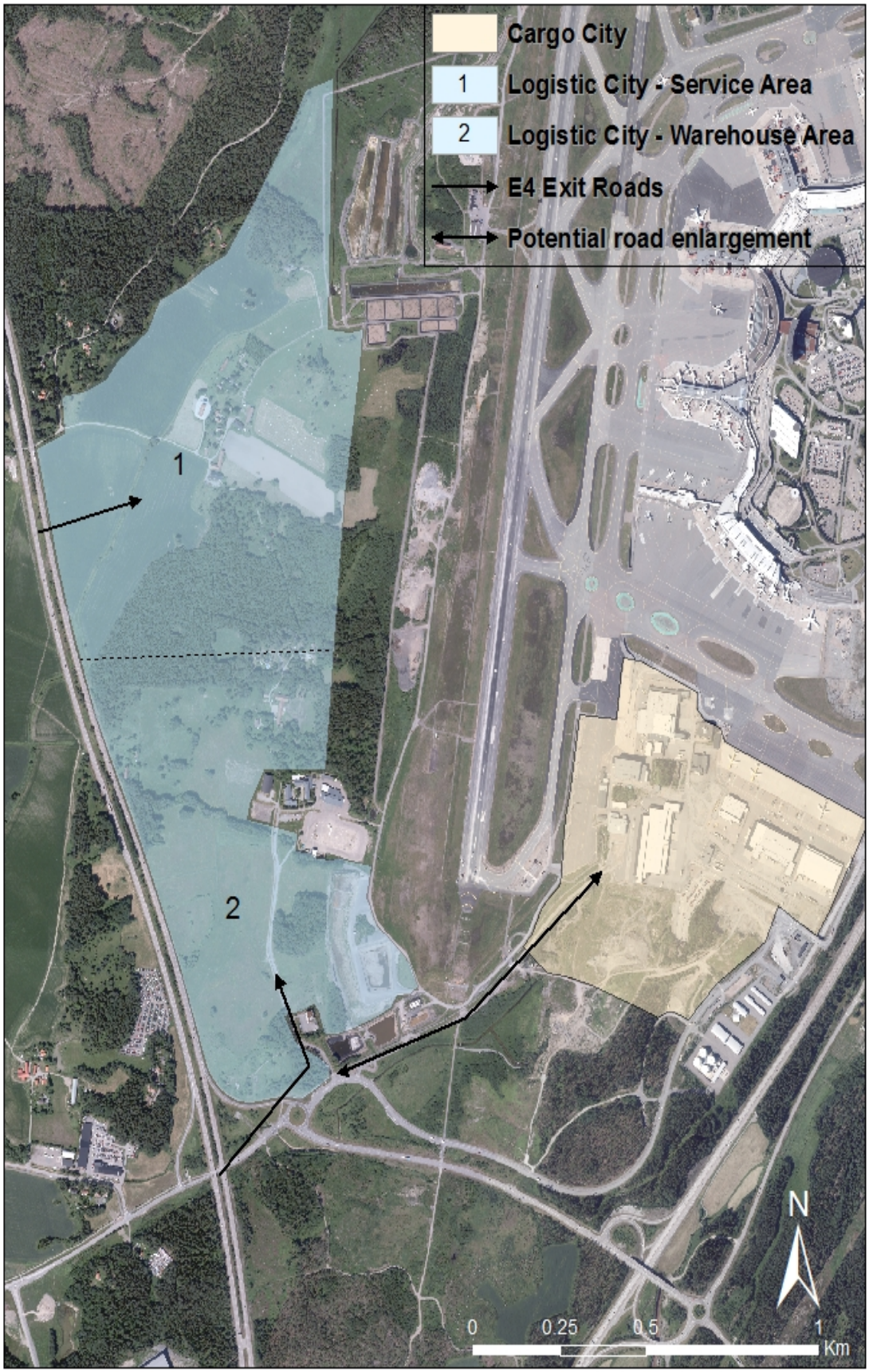
Ortophoto © Lantmäteriet

Alternative 1 Low



Ortophoto © Lantmäteriet

Alternative 2 High



Ortophoto © Lantmäteriet

Alternative 2 Low



Ortophoto © Lantmäteriet

4.10.3 Appendix III: Pictures from field observations

Pictures 1 and 2: Current area of Cargo City with warehouses and unloading places for air cargo

1



2



Pictures 3 and 4: Agricultural landscape in the area where the north part of Logistic City is suggested

3



4



Pictures 5 and 6: Forest landscape where the south part of Logistic City is suggested

5



6

