HALMSTAD UNIVERSITY

Master's Programme in Renewable Energy Systems, 60 credits

MASTER THESIS

Sustainability Assessment for Strategic Material Flows Between Planned Construction Projects in the Stockholm County

Mark Miyaoka

Dissertation in Energy Engineering, 15 credits

Halmstad 2015-08-29

Sustainability Assessment for Strategic Material Flows between Planned Construction Projects in the Stockholm County

Author:	Mark Miyaoka
Supervisor:	Dr. Jonny Hylander
Examiner:	Dr. Göran Siden
Date:	24 Aug 2015
Program:	Renewable Energy Systems
Level:	MSc

[Page Intentionally Left Blank]

Sammanfattning

Stadsutvecklingens behov av ballastmaterial kommer att öka dramatiskt under de kommande åren inom Stockholmsregionen och en signifikant miljöutmaning kommer att förknippas med stora flöden av ballastmaterial. Materialterminaler taremot bygg- och rivningsavfall, förädlar det och levererar återanvänd ballast till byggindustrin, detta bidrar till att minska efterfrågan på naturliga byggmineraler. Dessa material transporteras främst på vägar mellan materialterminaler och utvecklingsområden i Stockholmsregionen. Transportsektorn står för nästan en tredjedel av växthusgasutsläppen i Sverige, det finns en motivation för att undersöka de miljömässiga fördelar för att minimera transporterna av ballastmaterial. Denna studieomfattar kvantiteter av bygg- och rivningsavfall i formen av jord och berg massor från framtida utvecklingsområden och utgör en fallstudie i området gällande tre kommuner; Botkyrka, Huddinge och Haninge i södra Stockholm, baserat på deras kommunala översiktsplaner fram till år 2030. Detta har genomförts med hjälp av en programvara för markarbetsestimering, ESAR-modellen, utvecklad av Ecoloop AB. Avstånden mellan befintliga och planerade materialterminaler och framtida utvecklingsområden tillsammans med de uppskattade materialkvantiteterna har kombinerats för att upskatta totala fordonskilometer för transport av dessa material i ett business-as-usual scenario fram till 2030. En jämförelse har gjorts för ett alternativt scenario med strategiskt placerade materialterminaler inom fallstudieområdet, varvid en metod har utvecklats för att strategiskt placera materialterminaler baserat på GIS-programmet ArcMap tillsammans med kartlager för marktillgänglighet för lokalisering av materialterminaler som tidigare utvecklats inom ramen för en relaterad studie. I jämförelse med business-as-usual, att utnyttja befintliga och planerade materialterminaler, minskar en strategiskt placerad materialterminaler inom fallstudieområdet transportavståndet för utgrävda jord-och berg massor från utvecklingsområden till de materialterminalerna med cirka 42 % eller 3,67 miljoner fordonskilometer, vilket motsvarar en minskning med 3478 ton CO2e inom hela tidshorisonten för denna studie. Ett annat resultat från ESAR-modellen är att den uppskattar behovet av ballastmaterial för återfyllning av material. En materialflödesanalys för en strategiskt placerad materialterminal indikerar att materialterminalen kan uppfylla återfyllningsbehov för ballastmaterial i form av återanvänd ballast i hela sin verksamhet. Den totala minskningen av transportavstånd för material in och ut från utvecklingsområden är 45% eller 5,54 miljoner fordonskilometer, vilket motsvarar en besparing på 5248 ton CO2e. Utsläppsminskningar av växthusgaser från strategiskt belägna materialterminaler kommer sannolikt att också vara betydande bortom gränserna för denna studie och motivera ytterligare forskning.

Abstract

Urban development demands on construction aggregates are set to rise dramatically over the coming years within the Stockholm region and a significant environmental challenge will be associated with the large flows of construction aggregates and excavated materials in and out of future development projects respectively. Material banks receive construction and demolition waste (CDW), process this waste and supply recycled aggregates to the construction industry helping to reduce the demand on natural construction minerals. The transportation of these material flows between the material banks and development areas is predominantly by road in the Stockholm region. With the transport sector responsible for almost one third of green-house-gas (GHG) emissions in Sweden, there is a motivation for investigating the environmental benefits of minimising transportation distances of construction aggregates. Quantities of CDW in the form of excavated granular soil and rock from future development locations within a case-study area comprising three municipalities; Botkyrka, Huddinge and Haninge, in the south of Stockholm, have been estimated based on their municipal comprehensive plans up to the year 2030. This has been done with the assistance of an earthworks estimation tool, the ESAR model, developed by Ecoloop AB. Distances between existing and planned material banks and future development areas together with the estimated material quantities have been combined to approximate total vehicle-kilometres for the transportation of these materials under a business-as-usual scenario up until 2030. A comparison has been made to an alternative scenario of strategically located material banks within the case-study area, whereby a methodology has been developed within this study to strategically locate material banks utilising GIS software ArcMap together with land availability map layers for siting material banks previously developed under a separate related study. In comparison to the business-as-usual scenario, one strategically located material bank within the case-study area reduces total material haulage distances of excavated granular soils and rocks from development areas to the material banks by approximately 42% or 3.67 million vehicle-kilometres, equating to a reduction of 3478 tonnes of CO_2e throughout the time horizon of this study. Another output from the ESAR model is the estimated construction aggregate demand for sub-surface earthworks backfilling activities. A material flow analysis for the strategically located material bank indicates that the material bank is able to satisfy the sub-surface backfilling construction aggregate demand in the form of recycled aggregates throughout its operation. Considering the flow of recycled aggregates back to development areas for backfilling earthworks activities, a total combined reduction of 45% or 5.54 million vehicle-kilometres of material haulage distance is achievable, equating to a saving of 5248 tonnes of CO_2e. Reductions in GHG emissions from strategically located material banks are likely to also be significant beyond the boundaries of this study and warrant further research.

Acknowledgements

I would like to sincerely thank everyone that has assisted me throughout my thesis. I am grateful to the many brilliant colleagues within Ecoloop AB, where this thesis was carried out, who time and time again showed patience and offered guidance along the way. A particular thank you to my Supervisor Maria Johansson for her ability to consistently see the bigger picture and give me focus to achieve the objectives of the study within the limited time frame. Thanks also to Josef Mácsik, for taking the time to provide technical insight and advice on numerous occasions and Simon Magnusson for sharing and explaining much of his previous work on which this study is founded upon. A warm thanks to Jonny Hylander the programme Director at Halmstad University who has encouraged and supported me throughout my studies and to all my fellow colleagues who I hope to meet again sometime in the not so distant future. Last but not least, to my beloved Caroline for her positive energy, patience and support.

Halmstad August 2015

Mark Miyaoka

Table of Contents

1 *Introduction* 1

1.1 **Background** 1

1.1.1 Greenhouse Gasses and the Latest Figures from Sweden 1
1.1.2 Industrial Minerals and the Need to Recycle CDW 2
1.1.3 GHG Emissions Related to Transportation of Primary Aggregates 3
1.1.4 Material Banks (CDW Recycling Facilities/Fill Banks/Material Terminals) 3
1.1.5 Project Optimass 5
1.1.5.1 ESAR Model 5
1.1.5.2 GIS Based Method for Locating Material Banks 7

1.2 **The Problem** 8

1.3 **Aim** 9

1.4 **Delimitations** 9

1.4.1 Development Areas 9
1.4.2 Construction Activities and Types of Developments 10
1.4.3 Time Horizon 11
1.4.4 Material Flows 11
1.4.5 The Materials 12
1.4.5.1 Excavated Materials 13
1.4.5.2 Backfilled Materials 13
1.4.6 GHG Emission Source 15

2 *Methodology* 16

2.1 **Estimation of Soil and Rock Quantities** 16

2.1.1 Building Developments 16
2.1.1.1 Main Inputs for the ESAR Model 16
2.1.1.2 Data Collection Sources 16
2.1.1.2.1 Population Projection, No. Of Floors and Development Timeline 16
2.1.1.2.2 Geology 16
2.1.1.3 Data Interpretation 17
2.1.1.3.1 Population Projection for Each District 17
2.1.1.3.2 Number of Floors 18
2.1.1.3.3 Commercial GFA for Districts 18
2.1.1.3.4 Development Timeline 19
2.1.1.3.5 Excavated Material 19
2.1.1.3.6 Grouping of Materials 20
2.1.1.4 Other Variables in the ESAR Model 21
2.1.1.5 Modification of ESAR Model Output for Material Flow Analysis 22
2.1.1.5.1 Bulked Masses for Transportation 22
2.1.1.5.2 Material Balance 22
2.1.2 Cross-Connection Södertörn 23
2.1.2.1 Data Collection Sources 24
2.1.2.1.1 Road Geometries 24
2.1.2.1.2 Geology 25
2.1.2.2 Data Interpretation 25
2.1.2.2.1 Tunnels 26
2.1.2.2.2 At-Grade, Embankments and Cuttings 26
2.1.2.2.3 Road Widening 26

2.1.2.2.4 Bridge Structures and Other Road Features 27
2.1.2.2.5 Road Foundations for Embankments 27
2.1.2.2.6 Road Pavement 27
2.1.2.2.7 Construction Timeline 27
2.1.2.2.8 Materials 28
2.1.2.2.9 Material Balance 28

2.2 Strategically Locating Material Banks 28
2.2.1 Existing Material Banks 28
2.2.1.1 Consideration of Temporary Existing Material Banks 29
2.2.2 Steps for Strategically Locating a Material Bank 30
2.2.3 Transportation Routes to and from Existing and Strategically Located Material Banks ... 30
2.2.3.1 Business as Usual Scenario – Utilisation of Existing Material Banks 30
2.2.3.2 Strategic Material Banks Scenario 31
2.2.3.3 Transportation Route Data Collection 31
2.2.4 Assigning Material Banks to Development Areas 31
2.2.5 Selecting Strategically Located Material Banks 32
2.2.5.1 A Check of Material Flows into and out of the Selected Material Banks 32

2.3 GHG Emissions from Transportation 32

3 Outputs from Key Stages of the Study 34

3.1 Strategically Locating Material Banks 34
3.1.1 Identifying Clusters of Developments Furthest Away from Existing Material Banks 34
3.1.2 Material Flows into and out from Development Areas 35
3.1.3 Identifying Potential Material Bank Sites 36

3.2 Selection of Material Banks 38

3.3 Material Flow Analysis 40
3.3.1 SMB1 Only 40
3.3.2 SMB1 and SMB3 41

3.4 GHG Emissions Calculation Output 42

4 Analysis and Discussion 43

4.1 Strategically Located Banks versus Business-As-Usual 43
4.1.1 A Surplus of Recycled Aggregates 44

4.2 Factors Influencing the Results 44
4.2.1 Geology 45
4.2.2 Rock Quality 45
4.2.3 HGV Laden Values 45
4.2.4 Assumptions and Parameters of the ESAR Model 45
4.2.5 Development Timeline 46
4.2.6 Percentage of Site Reuse 46
4.2.7 Population Projections 46

5 Conclusions and Recommendations 47

5.1 Conclusions of the Study 47

5.2 Recommendations for Future Similar Studies 47
5.2.1 ESAR Model Validation 47
5.2.2 Employment Projections 48

5.2.3 GIS Map Layers for Degrees of Availability 48
5.2.4 Incorporation of SGU's Rock Quality Map 48
5.2.5 Methodological Alternatives 48
5.2.5.1 Identifying Development Clusters Located Furthest Away from Material Banks.... 48
5.2.5.2 Obtaining Transportation Routes 49
5.2.6 Collaboration with Municipalities 49
5.2.6.1 Standardisation of MCPs 49
5.2.6.2 Incorporation of Strategic Material Banks into MCPs 49

6 Further Research 50

6.1 Additional Environmental Benefits Beyond the Problem Boundary 50

6.1.1 Other CDW Materials 50
6.1.2 LCA of Strategically Located Material Banks 50
6.1.3 Delimitations on Construction Activities and Development Types 50
6.1.4 Cohesive Soils 50

6.2 Validation of the Study 51

6.3 Competition Among Material Banks 51

6.4 Consideration of Temporary Existing Material Banks 51

6.5 Optimising Material Logistics 52

6.6 Economical Considerations 52

6.7 Concluding Remarks 52

7 References 54

List of Figures

Figure 1: Tuen Mun Public Fill Bank, Tuen Mun, Hong Kong.
Figure 2: DA Mattson Material Bank (and Recycling Facility).
Figure 3: Simplification Process of the ESAR model for Residential Development Areas.
Figure 4: Degrees of availability for material banks in the Södertörn area presented using ArcMap.
Figure 5: Topographic Map of the Södertörn Area.
Figure 6: Construction Material Flows and the Demand and Supply in Construction.
Figure 7: Problem Boundary within the Construction Material Flow Model.
Figure 8: Sub-surface Material Flow Diagram for Building Developments
Figure 9: Material Transportation Scenarios
Figure 10: Location of Cross-Connection Södertörn within the Study Area.
Figure 11: Previous Study Areas for Södertörnsleden.
Figure 12: Existing Material Banks and Quarries Within and Immediately Surrounding the Study Area.
Figure 13: Location of Development Areas and Existing Material Banks.
Figure 14: Total Material Flows into and out from Development Areas.
Figure 16: Possible Locations of Strategic Material Banks
Figure 17: Location of Strategic Material Bank (SMB1)
Figure 18: Degree of Availability at SMB1 Site
Figure 19: Location of SMB2
Figure 20: Degree of Availability at SMB2 Site
Figure 21: Location of SMB3
Figure 22: Degree of Availability at SMB3 Site
Figure 23: Developments with Reduced Material Transportation Distances from SMB1
Figure 24: Estimated Material Flows into and out from SMB1 from 2016 to 2030 (SMB1 only)
Figure 25: Estimated Material Flows into and out from SMB1 from 2016 to 2030 (SMB1 and SMB3)
Figure 26: Estimated Material Flows into and out from SMB3 from 2016 to 2030 (SMB1 and SMB3)

List of Tables

Table 1: Time Horizon for MCPs
Table 2: Included and Excluded Materials in the Material Flow Analysis
Table 3: Required Inputs into the ESAR Model for Material Quantities
Table 4: Available Information and Information Gaps within MCPs
Table 5: Bulking and Shrinkage Factors for Materials
Table 6: Data Sources for Estimating Earthworks Quantities for Cross-Connection Södertörn.
Table 7: Fuel Consumption Data for a 14T Distribution Lorry
Table 8: Inventory Data for Distribution Lorry and Diesel Combustion Emissions.
Table 9: Weighted Scores for Strategically Located Material Banks
Table 10: Vehicle-Kilometres and GHG Emissions for Business-As-Usual and Strategic Material Bank Scenarios.

Appendices

Appendix 1: Projected Populations and Timeline
Appendix 2: Commercial GFA
Appendix 3: Soil and Rock Types for Development Areas
Appendix 4: ESAR Model Inputs and Outputs
Appendix 5: Plans for Södertörnsleden
Appendix 6: Earthworks Quantity Estimates for Cross-Connection Södertörn
Appendix 7: Weighted Scoring Method for the Selection of a Strategically Located Material Bank
Appendix 8: Material Flow Analysis for Strategically Located Banks
Appendix 9: GHG Calculations

List of Abbreviations

CDW	Construction and Demolition Waste
ESAR	Excavated Soil and Rock
GFA	Gross Floor Area
GHG	Greenhouse Gas
HGV	Heavy Goods Vehicles
LCA	Life-Cycle Assessment
MCP	Municipal Comprehensive Plan
RUFS 2010	Regional Development Plan for Stockholm's Region (2010)
SMB	Strategic Material Bank
vkm	Vehicle-Kilometres

List of Definitions

At-Grade Road	Road alignment within 1m from existing ground level
Granular Arisings	Excavated inert sands, gravels and rock
Material Bank	Temporary storage/sorting/processing facility for CDW producing recycled construction aggregate
Primary Aggregate	Quarried construction aggregate
Recycled Aggregate	Processed (crushed/sorted) CDW
Road Embankment	Road alignment 1m over existing ground level
Road Cutting	Road alignment 1m below existing ground level
Sub-grade/Sub-surface	Any level below existing ground level

1 Introduction

The Stockholm region has set a development plan in motion for Stockholm to become Europe's most attractive metropolitan region under the Regional Development Plan for Stockholm's Region - RUFS 2010 (TRF, 2010). The population of Stockholm is projected to increase at a rapid rate of over 37000 persons annually to 2023 and exceed a total population of more than 3 million by 2045 (TRF, 2014). Residential and commercial development targets together with infrastructure ambitions have been detailed within the regional development plan and individual municipal comprehensive plans (MCPs) with a short, medium and long-term horizon (2020, 2030 and 2040 respectively) to cater for this anticipated rapid population growth.

A significant environmental challenge will be associated with the large flows of construction aggregates and excavated materials both into and out of these future development projects respectively. The environmental impact from material flows into and out from construction sites are related to fuel combustion within the engines of distribution vehicles and are directly proportional to transportation distances between the construction sites and material sources and receptors.

This study builds on previous academic work related to Project Optimass - an initiative established by Stockholm based Ecoloop AB that specialises in effective and efficient materials management in the construction industry. One of the key focus areas for Project Optimass is related to the establishment of material banks in strategic locations in order to facilitate more sustainable materials management. Such material banks receive, process, sort, upgrade and resell construction and demolition waste (CDW) in the form of recycled aggregates. Through strategically locating these banks, with a long term view on the development of a region, haulage distances of CDW and construction aggregates may be reduced resulting in both economic and environmental benefits. It is the environmental benefit from reduced material haulages resulting from strategically located material banks that this paper aims to evaluate.

1.1 Background

1.1.1 Greenhouse Gasses and the Latest Figures from Sweden

Under the fifth Assessment Report released by Working Group I of the United Nations' Intergovernmental Panel on Climate Change (UNIPCC) in 2013, climate change has been categorically linked to anthropogenic air pollution. The concentration of greenhouse gasses (GHGs) - comprising carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFC) - in the Earth's atmosphere has a direct affect on global temperatures, with increases in the atmospheric concentration of CO_2 being the largest contributor to global temperature rises since the Industrial Revolution (IPCC, 2013).

The primary source of today's elevated levels of CO_2 in our atmosphere is from the combustion of fossil fuels. The latest figures published by the European Union in 2014 show that in 2012, 57.6 million tonnes of GHG emissions - measured as CO_2 equivalent (CO_2e) - were released in Sweden (excluding land use, land-use change and forestry emissions and international bunkers) of which, the transportation sector contributed 19.1 million tonnes of CO_2e representing 33.2% of the total GHG emissions – higher than that of the EU-28 average of 19.7%. Road transportation accounts for the largest part of the total GHG emissions within the transportation sector, responsible for 17.9 million tonnes of CO_2e or 93.7% of the transportation sector's total, excluding international bunkers (COM, 2014a). The main reason for Sweden's transportation sector being the dominant contributor to the overall GHG emissions is a result of Sweden's energy mix, which in 2012, comprised 51% of renewable energy compared to the EU-28 average of 14.1% (COM, 2014b).

1.1.2 Industrial Minerals and the Need to Recycle CDW

The Geological Survey of Sweden (Sveriges Geologiska Undersökning, SGU) defines an industrial mineral as "a rock, mineral or other naturally occurring material of economic value" (SGU, 2015). Primary aggregates are industrial minerals that are commonly used in construction and comprise either naturally deposited sands and gravels or are a product of crushing hard, strong rock formations – typically limestone, igneous rocks and sandstones (Zuo et al., 2013).

Sweden currently consumes about 85 million tonnes of aggregates annually for roads, railways and concrete (SGU, 2015). The primary aggregate supply has seen a dramatic shift from the use of limited natural sand and gravel resources to crushed rock as the priority now is to protect groundwater assets that rely on these naturally formed ridges of sand and gravel (SGU, 2015). With many existing gravel pits scheduled to close within the next 10-15 years, the use of alternative materials and reusing existing materials must increase (TRF, 2010).

The definition for CDW varies within literature with some definitions all inclusive of surplus materials arising from construction and other definitions omitting excavated soil and rock from CDW (Magnusson et al., 2015). For the purpose of clarity, mention of CDW within this paper refers to all surplus materials arising from construction activities on site.

Large amounts of CDW are generated in the construction sector and little is known on their actual quantities (Magnusson et al., 2015). Excavated rock, sands and gravels (herein referred to as granular arisings) as well as various other inert CDW materials such as demolition concrete from structures and asphalt from road plainings are proven to be of high reusability for civil engineering purposes and can hence replace quarried materials (Magnusson et al., 2015, Blengini and Garbarino, 2010, Simion et al., 2013). Environmental benefits from replacing these quarried materials with recycled CDW have been investigated and confirmed in numerous studies (Blengini and Garbarino, 2010, Simion et al., 2013).

Magnusson et al., 2015, summarises the environmental and economic benefits for onsite reuse of excavated soil and rock through the effective planning of mass balancing of earthworks and highlights the constraints of available space within dense city regions for onsite sorting of CDW. Granular arisings that are not reused onsite are commonly transported to recycling facilities or to a temporary storage facility. In Stockholm, the annual quantity of granular arisings (in the form of excavated rock) from construction activities is estimated to be almost half of the total aggregate demand for the region (SGU, 2015). One recent approximation of the quantity of recycled CDW materials in 2010 in Sweden is 50%, although this figure is subject to considerable uncertainty (Swedish EPA, 2012). There is a large potential benefit of maximising the recycling of CDW from an industrial mineral preservation perspective and this is a key focus area for the Swedish EPA which has set an objective of a nominal 70% reuse of CDW materials by 2020.

1.1.3 GHG Emissions Related to Transportation of Primary Aggregates

The development of the Stockholm Region over the coming years will place a large demand on primary aggregates as well as generate significant quantities of CDW. Within RUFS 2010, there is a highlighted need to reduce the environmental aspects relating to the use and transportation of aggregates (TRF, 2010). It is estimated that transportation of aggregates alone accounts for between 20-40% of the CO_2 emissions from the entire aggregate industry with the majority of aggregates being transported by road (Fry, 2007). Reduced environmental impact from the transportation of aggregates is suggested to be done through securing regional sites for centrally located aggregate banks as well as considerations for an increased proportion of transportation of aggregates by rail and by boat (TRF, 2010).

Numerous Life-Cycle Assessments (LCAs) have been conducted on infrastructure projects to quantify the contribution of the main elements of a project to the overall GHG emissions. Some studies indicate that the energy consumption and greenhouse gas emissions associated with transportation of construction aggregates can account for up to 20-30% of the total energy consumption and GHG emissions from the construction stage (Mroueh 2001, Egis 2010), whilst others suggest this proportion to be less contributory to overall construction stage emissions such as Barandica et al. 2013 (0.4 – 2.2% of total GHG emissions). Invariably, construction projects have a high degree of uniqueness; haulage distances, construction elements (such as tunnels and cuttings) and topography, being just some of the variables that can significantly affect the weighting of material transportation on the overall construction stage GHG emissions for infrastructure projects.

With the quarries close to built-up areas in Stockholm County largely exhausted, there is now a shortage of rock from quarries in the county (TRF, 2010). Densification of built-up areas is a key strategy of Stockholm's Regional Development Plan, thus new production sites would likely be established further away from these built-up areas where land is less scarce (Vaivars, 2010). This will inevitably result in longer haulage distances and thus increased GHG emissions associated with transportation of primary construction aggregates.

1.1.4 Material Banks (CDW Recycling Facilities/Fill Banks/Material Terminals)

CDW recycling facilities have arisen over the years from numerous driving factors. Not only are there environmental and economic benefits associated with the reduced consumption of virgin construction minerals, but there is also the recognised need and environmental benefits of preserving limited landfill capacities (Lu and Tam, 2013). In Hong Kong, where there is an urgent need to reduce waste going to landfills, inert fill reception facilities have been established to receive CDW and process the hard inert materials into recycled aggregates for use in construction activities (Lu and Tam, 2013). Figures 1 and 2 present photographs of

CDW storage and recycling facilities in both Hong Kong (publicly operated) and Sweden (privately operated).

Figure 1: Tuen Mun Public Fill Bank, Tuen Mun, Hong Kong.
Civil Engineering and Development Department (CEDD). Size: 35 Ha. Capacity: 4.9M m^3. Photos: Mark Miyaoka

Figure 2: DA Mattson Material Bank (and Recycling Facility).
Vallsta, Upplands Väsby, Sweden. Privately owned. Photo: Mark Miyaoka

The suitability for reuse of excavated soil and rock is dependent upon the material's geotechnical (e.g. particle size distribution, hydraulic conductivity etc.) and geo-environmental (e.g. organic content, leachate concentration etc.) properties (Magnusson et al., 2015). Surplus materials of high reusability (section 1.1.2) are more commonly sent to recycling facilities whilst surplus material of low reusability such as surplus wet cohesive soils will often be disposed of.

The proximity of a recycling facility to active development sites is vital to its economic viability and environmental impact with shorter distances resulting in reduced transportation costs and transportation related GHG emissions (Magnusson et al., 2015). Today, the common practice in Sweden is for material flows to be managed at a project level and often by the Contractors (Magnusson et al., 2015, Morén, 2015). Several of the larger construction companies in Sweden such as Skanska, NCC and PEAB, have their own aggregate production divisions, supplying material for their own operations and to other customers (Vaivars, 2010).

It is seldom the case that materials management is strategically considered at the regional level (Morén, 2015). Through in-depth interviews, Morén, 2015, has highlighted the recognised need and known benefits from incorporating CDW recycling facilities into Municipal Master Plans amongst key stakeholders and attributed one possible reason for the lack of such planning to inadequacy of data on CDW quantities. This is in-line with the findings of Magnusson et al., 2015.

(For the purpose of clarity, the term material bank used in this report shall refer to CDW recycling and storage facilities.)

1.1.5 Project Optimass

This study builds on previous academic and in-house work related to the research project "Optimass" - an initiative established by Stockholm based Ecoloop AB that specialises in effective and efficient materials management in the construction industry. One of the key focus areas for Optimass is related to the establishment of material banks in strategic locations in order to facilitate more sustainable materials management. Previous research work undertaken related to Optimass that is relevant to this study has been the development of a tool for estimating excavated soil and rock quantities at a regional level, the "ESAR Model", and a GIS based method for localising potential material bank sites based on various constraints and criterion. These two research projects will be briefly described in the following sub-sections.

1.1.5.1 ESAR Model

The Excavated Soil and Rock (ESAR) Model is a tool developed by Ecoloop AB in order to approximate sub-surface earthworks quantities (demand and supply) for residential, commercial and infrastructure developments using information at a municipal planning level only (such as population growth estimations, average number of floors, gross floor area/office area and approximate development areas). The model was primarily developed to address a recognised need for estimations of future quantities of excavated soil and rock at a regional level in order to facilitate optimally located material banks based on anticipated material flows (TRF, 2010, SGU, 2015, Magnusson et al., 2015, Morén, 2015). The methodology for the development of the model associated with ESAR flows for residential development areas is described in research work carried out in the paper titled: *"Sustainable Mass Handling - Modelling quantities of excavated soil and rock in residential construction projects"* (Israelsson, 2014).

In essence, first detailed models were constructed for housing construction and roads and trenches (infrastructure) construction, using generic foundation construction and geometric principles. Next, the detailed models were combined into one simplified model which uses mean and standardized values and relates the quantity of ESAR to the number of residents in the area. The detailed and simplified model were then tested on an existing residential development area for which actual ESAR volumes were referenced – the Annedal Case Study, which revealed a deviation between the simplified model and referenced ESAR volumes of 3.8% (Israelsson, 2014). The simplification process is exemplified in the steps shown in Figure 3.

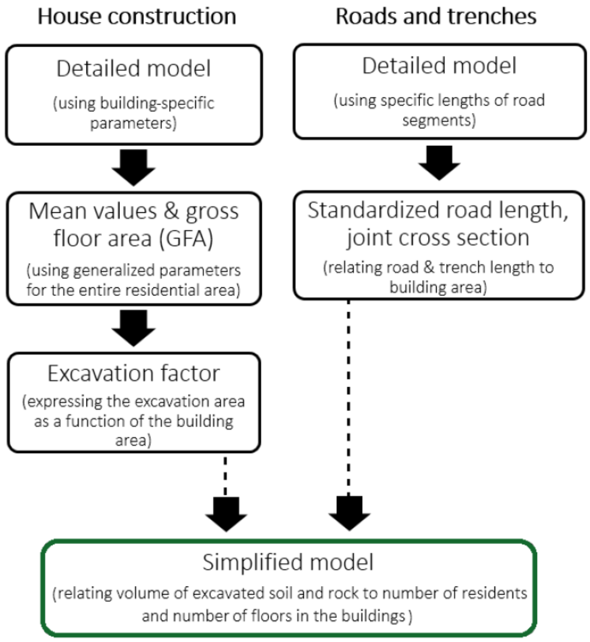


Figure 3: Simplification Process of the ESAR model for Residential Development Areas. (Israelsson, 2014)

The findings from the model based on the Annedal Case Study were compared to case studies detailed in a paper by Gangolells et al., 2009, whereby 4.83 and 4.95m^3 of excavated soil and rock per square meter of site occupancy was generated during the construction of two different multi-family houses. These values were compared to values developed theoretically with the ESAR model of 5.40 – 6.16 m^3/m^2 of ground area covered by the buildings. Israelsson noted that in Gangolells et al.'s work, the term "site occupation" did not specify whether or not this area incorporated the area covered by the houses only or a larger area including space taken up by vehicles, excavators and auxiliary equipment on the site. Nevertheless, Israelsson concluded that the comparison gives a positive indication of the applicability of the theoretical approach on which the ESAR model is built when considering that *"the primary goal of the calculation model is not to as accurately as possible estimate the volume and mass of ESAR generated in a residential area, but rather provide an easy and early usable method to create a template volume for planning purposes"* (Israelsson, 2014).

The model was subsequently enhanced with the addition of commercial developments and infrastructure outside of these development areas by Ecoloop AB. The basis for the commercial developments largely follows the principles and logic of the prior work done by Israelsson (2014) for residential development areas (Magnusson, 2015), whereas the infrastructure developments related part of the ESAR model focus primarily on city road infrastructure and is built upon local construction standards together with simplified road geometrical assumptions (Magnusson, 2015).

1.1.5.2 GIS Based Method for Locating Material Banks

A Geographic Information System (GIS) based method for locating material banks has been developed and detailed in a Master Thesis titled: *"Lokalisering av ytor för hantering av jord - och bergmaterial i Södertörn"(translated to: "Locating areas for management of soil and rock materials within Södertörn")* (Morén, 2015). The principal goal of the paper was develop a visual based method for identifying potential sites for material banks within the Södertörn area. To achieve this, information was gathered through interviews with key stakeholders in the materials management industry along with a literature study to identify the criterion that determines favourable and less favourable locations for material banks. The initially identified criterion were critically reviewed and refined to those that all interviewees agreed upon. The refined criterion were then subdivided into those that were considered to have a positive, negative or neutral impact on location, with neutral typically representing areas where it would be possible for material banks to be established following further in-depth consideration. The assigned attributes were translated into geographical information and input into GIS software ArcMap. Attributes were grouped into 4 degrees of availability; high, moderate, low and very low, based on possible combinations of attributes for a given area. The results of the GIS based method using ArcMap for the Södertörn area are shown in Figure 4.

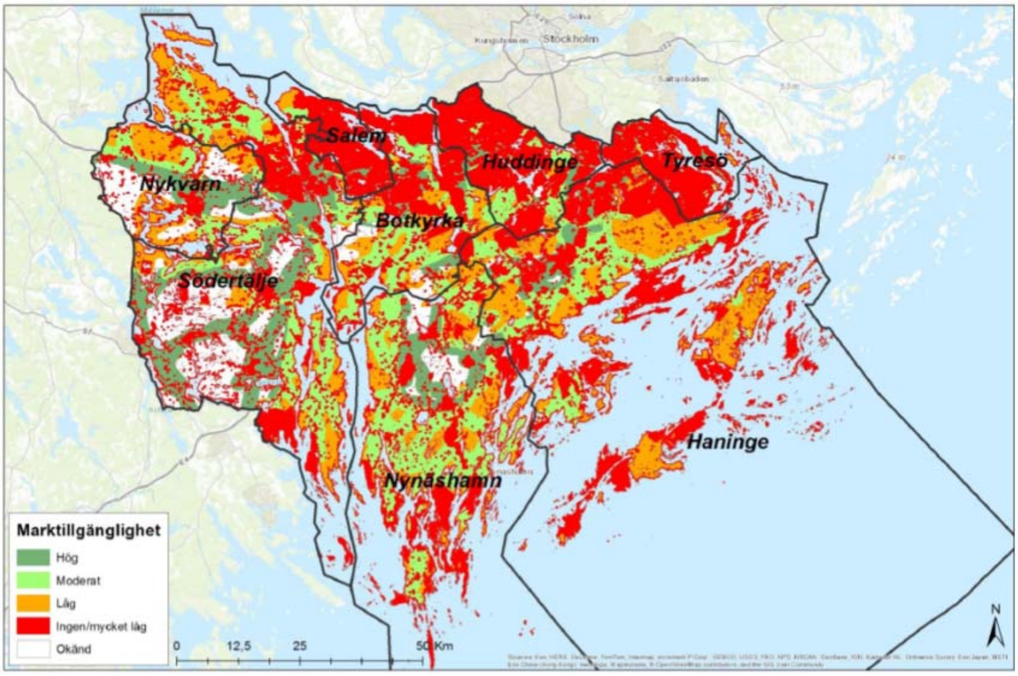


Figure 4: Degrees of availability for material banks in the Södertörn area presented using ArcMap. (Morén, 2015).

The paper then progresses onto performing a case study scenario for selecting a potential material bank site. This is done by plotting 10km radius circles around potential future development areas, identifying surfaces with high degrees of availability, eliminating surfaces with insufficient land for setting up a material bank (nominal criteria > 2Ha) and finally conducting an example transport analysis using network lines obtained from Trafikverket's network database "Lastkajen". Further details of the steps and results are presented in the paper (Morén, 2015). It is important to note that hypothetical quantities of soil and rock were used in order to develop the case study scenario.

1.2 The Problem

There is a recognised environmental need, together with economic and environmental benefits, to increase the use of recycled aggregates in the construction industry as well as consider methods to optimise transportation of these aggregates with respect to transportation mediums and proximity between supply/receptor facilities and construction sites (TRF, 2010, SGU, 2015, Swedish EPA, 2012, Magnusson et al., 2015, Blengini and Garbarino, 2010, Simion et al., 2013). Transportation of primary aggregates and CDW is predominantly carried out by road (Fry, 2010) and distances are likely to increase as urban areas become more densely developed (Vaivars, 2010, TRF, 2010). With almost one third of Sweden's GHG emissions in 2012 originating from the transport sector and road transportation in particular being the dominant source of emissions accounting for 93.7% of GHG emissions (excluding international bunkers) (COM, 2014a), reducing transportation related emissions will have a significant contributory factor to Sweden's total GHG emissions.

A Regionally Coordinated Materials Management Approach

The common practice today in development projects is to pass the management responsibility for material flows onto the construction company contracted to carry out the project (Magnusson et al., 2015, Morén, 2015). With some of the main Contractors also owners and operators of their own materials suppliers (Vaivars, 2010), transportation distances for material flows are not necessarily to the nearest facilities. Furthermore, little data is known as to the quantities and fate of CDW generated from projects – a likely result of the individually managed material flows for each construction project.

The benefits of a coordinated materials management approach between projects has been highlighted in a case study report by CL:AIRE (Contaminated Land: Applications in Real Environments) in 2013. The report is based on a "Cluster Project" in the Northwest of England involving four remediation sites in relatively close proximity to one another and one common temporary decontamination/treatment facility (recycling facility) which received, treated and redistributed non-hazardous contaminated soils for reuse. When compared to single-site remediation projects (i.e. business-as-usual), a total of 97,000 miles (156,000 kilometres) were saved in lorry transportation distances resulting in a net 109 tonnes savings in CO_2 emissions (CL:AIRE, 2013).

There is a desire to incorporate strategic materials management into Municipal Master Plans amongst key stakeholders in Stockholm (Morén, 2015, TRF, 2010). One possible reason for the lack of such planning has been attributed to an inadequacy of data on CDW quantities (Morén, 2015). The SGU is currently developing a proposal in consultation with the Swedish EPA on how the data on granular arisings (predominantly excavated hard materials suitable for reuse as construction aggregates) in the construction industry can be collected, with the final report scheduled for release in December 2015 (SGU, 2015).

1.3 Aim

There is a clear motive for reducing transportation emissions related to the movement of materials to and from construction sites and whilst most of this is currently handled on a project level, little is done at the regional level through a broader coordinated materials management approach. This study has an evaluative purpose: *"To investigate the potential environmental benefits in terms of reductions in CO_2e, of strategically located material banks between future development areas, detailed within long-term municipal comprehensive plans in the Södertörn area, with a focus on reducing material transportation distances".*

Under a prior study undertaken by Morén (2015) to demonstrate a GIS based methodology for strategically locating material banks (section 1.5.1.2), hypothetical quantities of soil and rock were used in order to develop a case study scenario. This study aims to have a more representative estimate of soil and rock types and quantities from future development projects within three municipalities of the Södertörn area; Botkyrka, Haninge and Huddinge, based on the latest municipal comprehensive plans (MCPs), using Ecoloop's ESAR model (section 1.5.1.1). These more representative quantities will be used to strategically locate material bank sites and, through the comparison of transportation distances between the strategically located banks scenario versus a "business-as-usual" alternative, offer an estimate of the environmental benefits in terms of CO_2e from reduced transportation distances of granular arisings and recycled aggregate.

1.4 Delimitations

Several delimitations have been made at the outset of this study in order to narrow down the broad extents of the problem whilst at the same time ensuring that the analysis boundaries are sufficiently inclusive to draw meaningful conclusions. Delimitations have been applied to the development areas, the construction activities and types of developments to be considered, the time horizon, the material flows, the materials to be considered and the environmental impact sources. These will be further elaborated in the following sub-sections.

1.4.1 Development Areas

The selected case study area is within the Södertörn area with a particular focus on future developments within three municipalities: Botkyrka, Haninge and Huddinge (Figure 5) herein referred to as the "Study Area". These three municipalities have been selected to be the primary focus of this study as they are adjacent to one another and the quantity of data from three municipalities is considered sufficient for the purpose of this study.

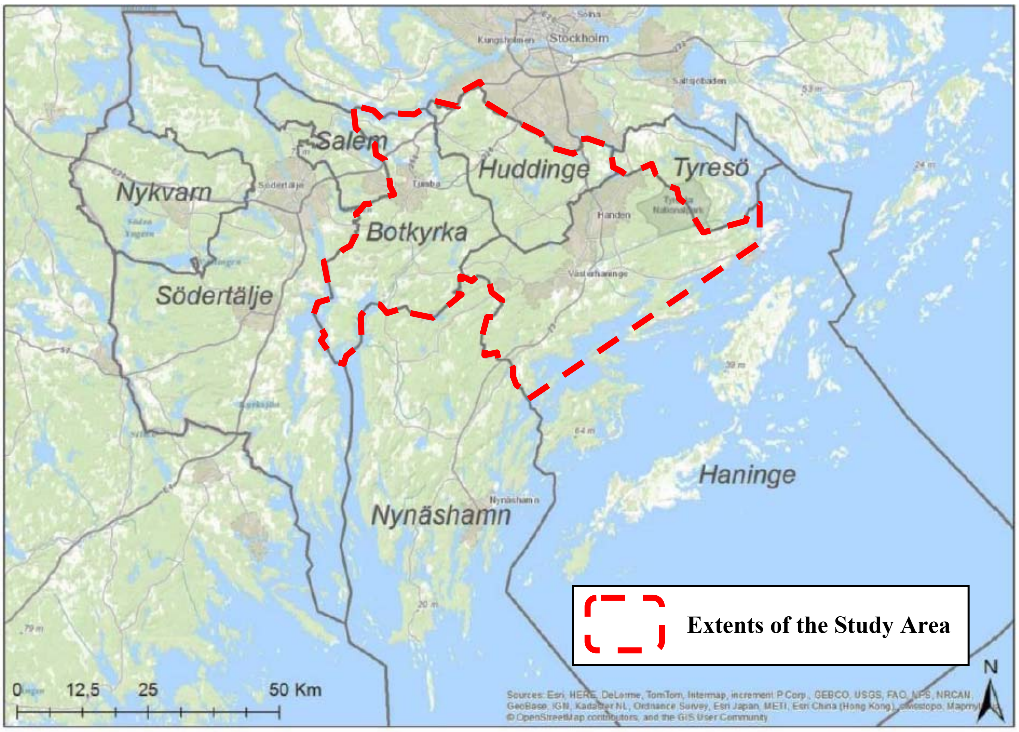


Figure 5: Topographic Map of the Södertörn Area.
(ESRI, open data)

1.4.2 Construction Activities and Types of Developments

The ESAR model is developed based on earthworks activities during the construction stage. For building development areas, the model considers sub-surface earthworks materials and excludes sub-surface structures (concrete retaining walls, spread footings etc.). For infrastructure developments, backfilling has been taken up to existing ground level and in the case of roads, earthworks has been extended to include pavement layers. Other earthworks related activities such site formation and landscaping have not been considered in the ESAR model and for the purpose of simplification, the topography has been assumed to be level.

The development types to be analysed with the ESAR model will be delimited to building developments and their associated infrastructure with a focus on multi-family dwellings (apartment buildings) and commercial buildings (industrial, municipal services, trade and offices) for which the largest quantities of earthworks are envisaged. Low rise residential houses (detached, semi-detached, terraced houses) and inner city roads beyond the residential and commercial development areas will not be considered in the material flow analysis.

In addition to the development types to be analysed using the ESAR model, a regional infrastructure project that is currently in the planning stages, known as the Cross-Connection Södertörn, has been included within the analysis. This is a county road that will span across two of the municipalities within the Study Area; Huddinge and Haninge and is to be constructed within the time horizon of the study. Given the scale of the project, it is likely to contribute a significant amount of material to the material flow analysis for the Study Area and as such, this infrastructure project has been included into the study. The estimated earthworks quantities for the county road project will be done utilising a bespoke spreadsheet incorporating known alignment details and road construction standards.

Other construction activities outside of the construction stage that give rise to aggregate flows such as maintenance, refurbishment and demolition activities have been excluded from the analysis boundary. These activities are seldom covered within MCPs and as their locations would be unknown, strategically locating material banks based on proximity to construction activities would not be possible. Furthermore, given that urban densification is a key theme to the Stockholm's regional development plan (TRF, 2010) it is assumed that strategically locating banks for planned construction sites would also be beneficial, in terms of proximity, to other construction activities arising from already developed areas.

1.4.3 Time Horizon

The time horizons for the most recent MCPs are summarised in Table 1.

Table 1: Time Horizon for MCPs

Municipality	MCP Issue Date	Time Horizon	Reference
Botkyrka	May 2014	To 2040	(Botkyrka Kommun, 2014)
Huddinge	May 2014	To 2030	(Huddinge Kommun, 2014)
Haninge	April 2015 (Draft)	To 2030	(Haninge Kommun, 2015)

As two of the three municipalities have time horizons up to 2030, the chosen time horizon for this study shall be 2016 to 2030.

1.4.4 Material Flows

A conceptual model for construction material flows has been developed by Magnusson et al. (2015) and presents the possible material flow paths for construction materials. The conceptual model is presented in Figure 6.

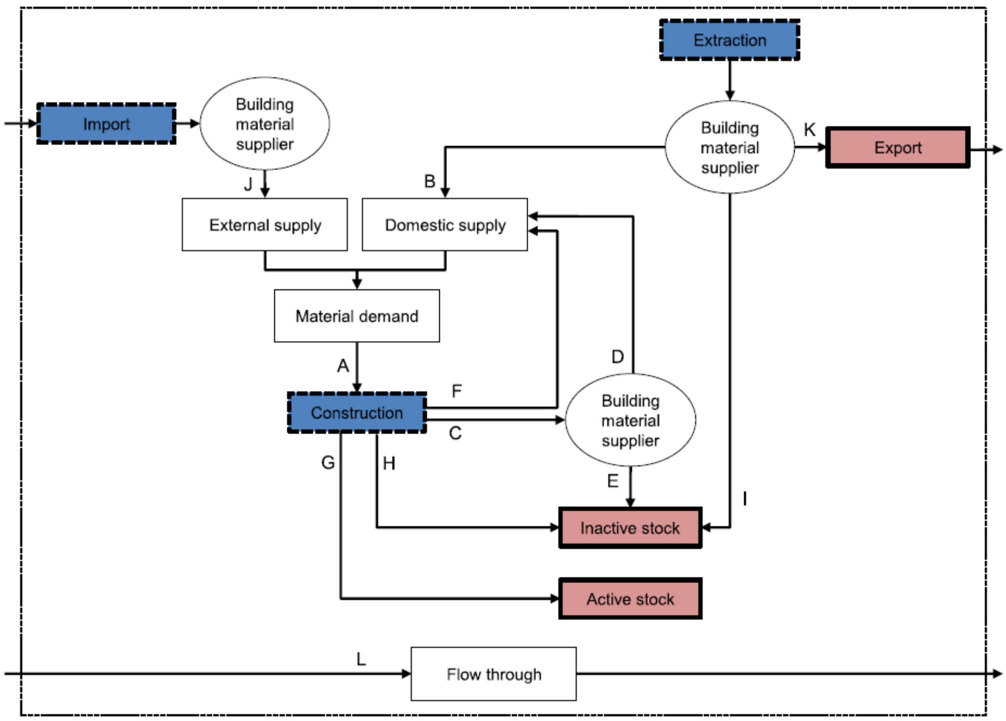


Figure 6: Construction Material Flows and the Demand and Supply in Construction. (Magnusson et al., 2015).

As can be seen in the model, construction material demands can be met by imports from outside of the system, extraction (e.g. quarries) or from residues from construction/industry (e.g. recycled CDW). The sources are illustrated as the blue boxes/dashed lines. The consumption of the construction materials within the system have been illustrated in red boxes/solid lines under the categories of Active stock (e.g. buildings, roads), Inactive stock (e.g. landfill of CDW) and Export (e.g. quarried materials leaving the system). A material bank that receives and recycles CDW would be positioned within the central building material supplier in the model above. To limit the scope of this study, a boundary is set around material flows between construction projects and material banks. Material flows from other external sources will not be considered. As material flows would be compared between a strategically located material bank and existing banks, any shortfalls in the material supply would be obtained from external sources in both scenarios thus justifying this delimitation. Similarly, it is assumed that CDW that is not recycled would be disposed of in the same manner under both scenarios. This boundary has been illustrated on the construction material flow model in Figure 7.

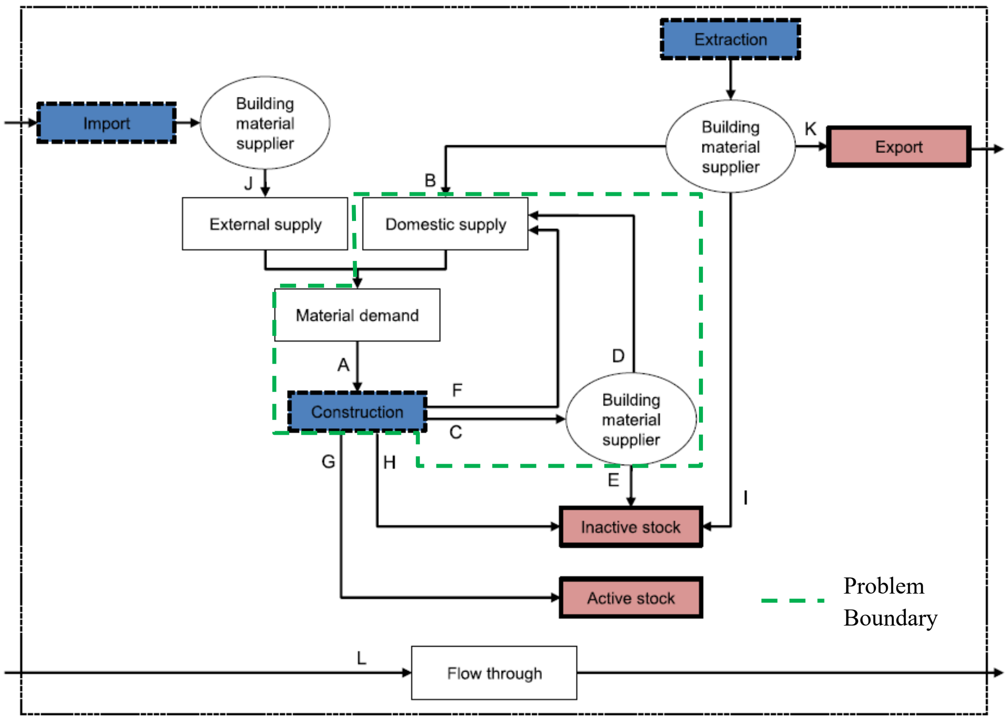


Figure 7: Problem Boundary within the Construction Material Flow Model.

1.4.5 The Materials

In section 1.4.2, it was mentioned that the construction activity to be considered for this analysis shall be delimited to earthworks during the construction stage. The materials that are associated with sub-surface earthworks activities and their movements are presented in a material flow diagram (Figure 8). The diagram is an example of sub-surface material flows for a building development project. It is an expansion of the problem boundary presented in the previous section (Figure 7), whereby a material bank represents the building material supplier. Construction material flows from external sources and to inactive stocks have not been expanded as they are considered to be beyond the problem boundary. The diagram has been constructed with inspiration from work carried out by (Bergstedt and Linder 1999, Magnusson et al. 2015 and Zuo et al., 2013).

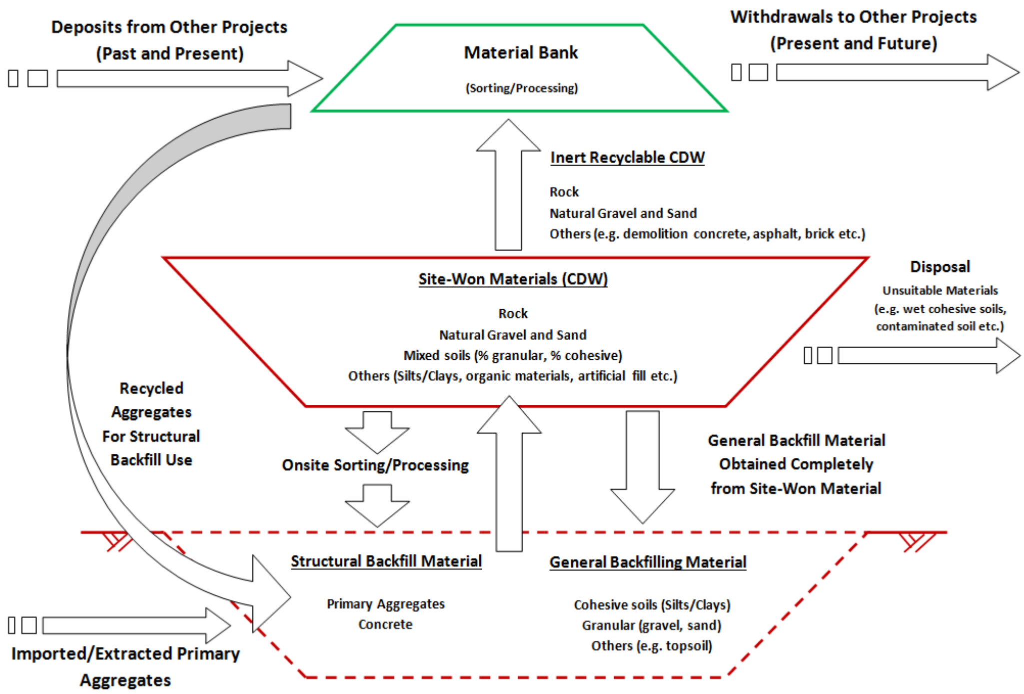


Figure 8: Sub-surface Material Flow Diagram for Building Developments

Materials to be considered for the material flow analysis fall under two categories; excavated materials and backfilled materials.

1.4.5.1 Excavated Materials

Excavated materials are delimited to recyclable inert CDW materials that arise from excavation work that are commonly handled by most of today's existing material banks - natural granular arisings (rock, gravel and sand). Concrete demolition arisings and other inert CDW such as bricks that can also be crushed into recycled aggregates have been omitted from the materials inventory in this analysis (as discussed in section 1.4.2) as well as artificial fill (made ground from previous land use) that may be sorted and give rise to inert recyclable CDW. The reason for this is that it is difficult to estimate quantities of recyclable CDW from areas of artificial fill without further geotechnical investigations (such as trial pits and boreholes). Such a level of detail is considered too high for the purposes of strategically locating material banks from a regional development perspective. Other excavated materials such as wet cohesive soils, whilst have potential value for reuse after treatment (another key focus area of the Optimass project), are today commonly disposed of (Magnusson et al., 2015) and as such, not considered to be delivered to the material banks under this study.

1.4.5.2 Backfilled Materials

As mentioned in section 1.4.2, in the case of building developments, backfilling materials to be considered are sub-surface earthworks materials and sub-surface structures (concrete retaining walls, spread footings etc.) have been excluded. For infrastructure developments, backfill required has been taken up to existing ground level and in the case of roads, earthworks has been extended to include pavement layers. Backfilling materials can be further sub-divided into those for general backfilling purposes and those for structural backfilling purposes.

General backfill is material used to fill in voids and does not perform any particular structural purpose. Examples are the backfilling of trenches for pipe laying once the pipe bedding and surround have been constructed and the backfilling of any over excavation for foundations (usually carried out to facilitate working space within excavations). The quantities of general backfill for building developments and infrastructure are built into the ESAR model (Israelsson, 2014). The general backfill is considered to come entirely from site-won materials and predominantly from cohesive materials. In the event that there are insufficient cohesive materials to satisfy general backfilling requirements, site-won granular materials are assumed to be used with a preference for utilising smaller aggregate particle sizes that require less onsite sorting and processing.

Structural backfill materials comprise construction aggregates selected for their specific characteristic properties. Examples are for uses such as drainage stone, granular pedestals and in the case of roads for this analysis, embankment layers up to the top of pavement. Similarly, structural backfilling materials have been differentiated in the ESAR model (Israelsson, 2014).

A summary of the materials to be included and excluded from the material flow analysis is presented in Table 2.

Table 2: Included and Excluded Materials in the Material Flow Analysis

Included Materials	
Excavated Materials	**Backfilled Materials**
Rock Sands and Gravels Moraine (Till)	General Backfill Cohesive soils Granular soils Structural Backfill Aggregates (Primary and recycled)
Excluded Materials	
Excavated Materials	**Backfilled Materials**
Wet Cohesive Soils Contaminated Soils Artificial Fill Organics Other CDW (Concrete, bricks etc.)	General Backfill Topsoil Structural Backfill Concrete

1.4.6 GHG Emission Source

The emission source to be considered is from the combustion of fuels for the transportation of the materials included in the material flow analysis (section 1.4.5) during the construction stage of development projects that result in the release of GHGs into the air. Figure 9 presents the comparison to be made between two alternative scenarios; with and without strategically located material banks.

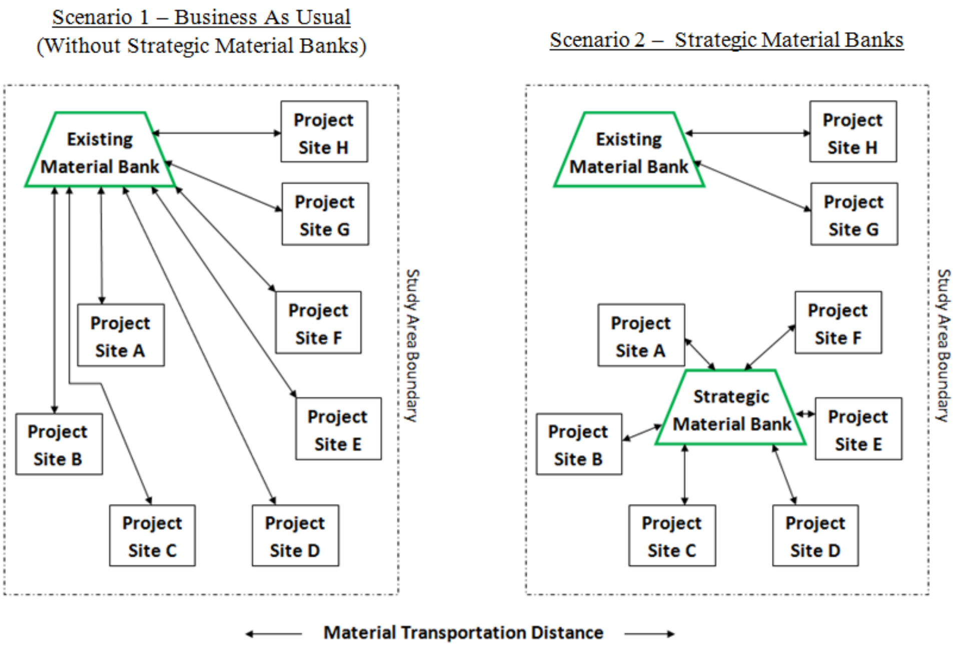


Figure 9: Material Transportation Scenarios

As can be seen in Figure 9, the environmental benefit of having strategic material banks is compared to the "business-as-usual" scenario of utilising existing material banks only. Under the strategically located material bank scenario, existing banks will also be included as these are assumed to remain operational throughout the development time horizon.

Indirect GHG emission sources may vary as a result of modified transportation distances. Such indirect sources may be from road maintenance vehicles associated with road wear and the life span of distribution lorries and hence GHG emissions related to their production etc. Such indirect GHG emission sources will not be considered in this study.

This study aims to compare the potential environmental benefits of strategically located material banks from a materials transportation perspective. Ultimately, it is the potential reduction in GHG emissions related to modified transportation routes that will be assessed. Although there would be other emissions such as those related to the loading and unloading of materials, their sorting and processing prior to loading and after unloading such emissions are assumed to be similar under both scenarios and are thus not considered in this study.

2 Methodology

This section presents the key stages in the methodology for how the purpose of this study was achieved mentioning data collection methods, interpretation of the data and assumptions made along with how any problems encountered were dealt with and what consequences they may have on the results.

2.1 Estimation of Soil and Rock Quantities

Soil and rock materials to be considered in the material flow analysis have been previously listed in Table 2 (section 1.4.5.2). Quantities of these materials were estimated using Ecoloop's ESAR model for building development projects and a bespoke spreadsheet for quantifying earthworks associated with a future large scale infrastructure project that traverses the municipal boundary between Huddinge and Haninge – the Cross-Connection Södertörn. The methodology used and assumptions made to estimate material quantities and types are discussed in the following sub-sections.

2.1.1 Building Developments

2.1.1.1 Main Inputs for the ESAR Model

The main inputs required for the ESAR model for different building development types are summarised in Table 3.

Table 3: Required Inputs into the ESAR Model for Material Quantities

Building Development Type	Main Inputs
Multi-Family Residential	Population Projection, No. of Floors
Low-rise Commercial/Industrial	Gross-Floor Area (GFA)
Multi-storey Commercial	Gross-Floor Area, No. of Floors
All	Geology, Development Timeline

For all development types, the geology is required to estimate excavated material types and a development timeline is required for the material flow analysis throughout the time horizon for this study, 2016-2030.

2.1.1.2 Data Collection Sources

2.1.1.2.1 Population Projection, No. Of Floors and Development Timeline

The primary source of information for population figures, building development projects and their timeline is from MCPs for the three municipalities (Botkyrka Kommun, 2014, Huddinge Kommun, 2014, Haninge Kommun, 2015).

2.1.1.2.2 Geology

In order to obtain an estimation of the material types being excavated, approximate locations for development areas was required along with geological information pertinent to those areas. The development areas were obtained from the MCPs and soil types were obtained from Quaternary deposit maps obtained in shapefile data format from SGU for import directly into GIS software ArcMap.

2.1.1.3 Data Interpretation

Due to a lack of standardisation between MCPs, the level of detail greatly varies amongst the plans. A summary of the available information and information gaps within the MCPs is presented in Table 4. The grey highlighted columns represent data required for the ESAR model and material flow analysis.

Table 4: Available Information and Information Gaps within MCPs

[Available information marked with (X)]

Municipal Comprehensive Plans (MCPs)	Population Projection For Each District	Population Projection For Grouped Districts	Overall Population Projection	Number of floors	Target Number of Homes to be developed	Proportion of Single Family Houses/Multi-family Apartments	Number of New Jobs	Commercial GFA for Districts	Commercial GFA for Significant Development Areas	Proportion of Commercial Development in Multi-storey Buildings	Areas for Development Within Districts Clearly Identified on a Plan	Development Timeline
Botkyrka		X	X		X		X	X	X			X
Haninge			X		X	X	X		X		X	
Huddinge			X		X		X		X		X	

As can be seen in Table 4, several information gaps were identified during the data collection stage that was crucial for constructing the material flow analysis. Assumptions and methods used to obtain the required information are presented in the following sub-sections.

2.1.1.3.1 Population Projection for Each District

Populations for each municipality in the first quarter of 2015 were obtained from Statistics Sweden (SCB, 2015). The overall high and low population projection for each municipality was detailed in the latest MCPs (Botkyrka Kommun, 2014, Huddinge Kommun, 2014, Haninge Kommun, 2015). However, in order to strategically locate material banks and obtain reasonably representative types of materials excavated, it is necessary to obtain information on development areas to at least the district level. As a result of the varying level of detail amongst MCPs, the interpretation was done differently for each municipality.

For Botkyrka, high and low population projections were known for grouped districts up to 2040. First these population figures were adjusted on a pro-rata basis to projections for 2030 to be in-line with the other municipalities and the time horizon for this study. Next, the population within each grouped district was split up into those assumed to be living in multi-family dwellings and those living in single-family homes. To do this, descriptive details within the MCP were the first point of reference, identifying those areas for which a specific development type is desired (e.g. areas designated for densification with apartment buildings and areas designated specifically for single family dwellings). For areas where this was not detailed in the MCP, housing statistics presented in a report from the Office of Regional Planning Stockholm County Council were used (Johnsson, 2010).

The number of new multi-family homes to be developed based on this extrapolation was then checked against the target number of multi-family homes to be developed (given in the MCP-Table 4). After this, the population figures for each grouped district were split up equally amongst individual districts in the group. This was an assumption made to facilitate estimations for population figures living in multi-family dwellings at the district level. As the districts had been grouped according to their location in Botkyrka (i.e. adjacent districts grouped), an equal split amongst the individual districts was considered to be an acceptable assumption that would not significantly impact the results. The steps of the population interpretation are presented in Appendix 1.

For Haninge, only the overall high and low population projection was given in the latest MCP. However, the MCP from 2005 (Haninge Kommun, 2005) provided information on population projections for the individual districts of Haninge up to 2025. This was used to first obtain a percentage split of the total projected population amongst the districts and, together with descriptive details in the latest MCP (including a given desired split of single and multi-family dwellings), was then used to apportion the total projected population living in multi-family dwellings to the individual districts. A check was also performed against given housing development targets in the MCP. The steps of the population interpretation are presented in Appendix 1.

For Huddinge, similarly to Haninge, only the overall high and low population projection was given in the latest MCP. However, in the case of Huddinge, the level of detail given for development areas and descriptions was higher than the other two municipalities and this facilitated the apportioning of the total projected population for the municipality amongst the districts. This was checked against development targets for homes in the municipality along with population figures presented for the districts as of 2011. The steps of the population interpretation are presented in Appendix 1.

2.1.1.3.2 Number of Floors

The number of floors is a requirement in the ESAR model for both multi-family dwellings and multi-storey commercial developments. The number of floors within each district is seldom specified within the MCPs. Where the number of floors was not detailed in the MCPs, the number has been assumed based on surrounding buildings using Google Maps Street Viewer (Google Maps, 2015). This is in line with a common statement in the MCPs which says that the appearance of the area should not be adversely impacted and the existing theme should be maintained (Botkyrka Kommun, 2014, Huddinge Kommun, 2014, Haninge Kommun, 2015).

2.1.1.3.3 Commercial GFA for Districts

Significant future commercial development areas were highlighted in all of the MCPs with Botkyrka’s commercial development plans coming primarily from an MCP released in 2002 and referenced as still valid in an Environmental Impact Assessment Report compiled by

Iterio AB (Iterio, 2014). The split between low-rise commercial and multi-storey commercial was assumed based on descriptions from the MCPs and surrounding areas. For example, commercial areas detailed within zones of densification where there were existing multi-storey buildings dominating the area, were assumed to comprise 100% multi-storey commercial developments, whereas areas detailed within specifically designated industrial areas were apportioned a larger weighting of low-rise commercial development. Due to a limited level of detail within the MCPs at the district level, only significant commercial development areas highlighted in the MCPs have been considered in the material flow analysis. These omissions will likely result in underestimations of material flows for commercial developments. However, the proportion of materials arising from commercial developments outside of the significant areas highlighted in the MCPs is considered to be small. The information extracted and interpreted from the MCPs related to commercial developments is presented within Appendix 2.

2.1.1.3.4 Development Timeline

Botkyrka was the only municipality to present an approximate timeline for development projects within their MCP (Botkyrka Kommun, 2014). However, within all of the municipal plans, annual housing development targets had been specified and were specified to be at a constant rate (e.g. 600 residential units per year for Haninge, Haninge Kommun, 2015). As the ESAR model relies upon population as an input variable, a constant rate of population increase was assumed for the other two municipalities. This assumption was considered to be in-line with the development targets and in-view of the lack of available information, was considered to be appropriate. The timeline breakdown for Botkyrka is presented in Appendix 1 along with the timeline assumptions made for Huddinge and Haninge.

2.1.1.3.5 Excavated Material

Areas for development were clearly defined within the MCPs for Huddinge and Haninge and defined in somewhat lesser detail within the Botkyrka MCP. In the case of Huddinge and Haninge, plans showing designated areas for development were highlighted within each district and accompanied with descriptions of the desired types of development (e.g. densification of existing built-up area with commercial and residential buildings, new development areas with a focus on multi-family dwellings etc.). In the case of Botkyrka, approximate areas were identified within the districts, using circles to identify those areas, and accompanied with descriptions of the types of developments desired in those areas. Upon further investigation of those circles plotted on the maps within Botkyrka's MCP, it was identified that those highlighted areas outside of built-up areas were located on plots of land that had little existing development. It was therefore concluded that the circles drawn in Botkyrka's MCP maps could be used to represent demarcated areas for development similar to the more detailed demarcations in the other two MCPs.

The areas for development were plotted into ArcMap and combined with the Quaternary soil map shapefile data (SGU, 2015). The areas for development were then clipped and percentages of soil and rock types were extracted over the entire development area. A few of the smaller development areas to the east of the Study Area fell outside of the extents of the Quaternary soil shapefile data obtained from SGU. In order to obtain representative percentages of soil types for these development areas, soil maps were obtained directly from SGU's website, the development areas were marked onto the maps and approximations were made by eye. The outputs of the soil and rock types encountered over the development areas are presented in Appendix 3.

In order to broadly approximate material types that would arise from excavation activities, certain assumptions had to be made. The first assumption was that, the topography was assumed to be level at all development sites. Although in reality, the topography is seldom level, site formation work and the final design ground level is not detailed until the later stages of development projects and as such, for the purposes of estimating materials at a regional level based on regional development plans, the assumption of a level topography is considered appropriate. This is also in-line with the ESAR model assumptions (Israelsson, 2014). A second assumption was that the actual building developments and associated infrastructure within defined development areas are spread equally. The reason for this assumption is that at the regional planning level, details such as building locations and associated infrastructure are not presented. This results in a rather high level of uncertainty between estimated soil and rock types and actual types to be encountered. Nevertheless, for the purpose of obtaining initial approximations of material types, this method is considered appropriate for the broad regional perspective at which material flows and considerations for strategically locating material banks is based upon. A third assumption was that the near surface geology extends to the full depth of excavations. Although the depth to bedrock could be obtained from SGU, intermediate soil strata would be unknown. Incorporating the bedrock level into the analysis alone would require a three dimensional analysis which was considered too detailed for the purposes of this regional scale study. Furthermore, for the purpose of identifying granular arisings (i.e. recyclable CDW of high value), this assumption is considered to be conservative as areas of bedrock unidentified from the Quaternary maps due to a shallow soil cover, would give rise to more crushed rock for buildings with basement structures and/or structures with deeper foundations.

2.1.1.3.6 Grouping of Materials

The materials encountered within the development areas have been grouped into five classifications; rock, sands and gravels, till, cohesive soils (clays/silts) and others (artificial fill, peat etc.). The groupings of the materials were made based on soil descriptions from the Quaternary maps along with knowledge about geological formations (Mácsik, Pousette and Jacobsson, 1998) and through discussions with a local engineering geologist (Mácsik, 2015).

Excavated Materials

The excavated materials included in the material flow analysis are rocks, sands and gravels and tills (Table 2, section 1.4.5.2). The most common rock types encountered within the Study Area are quartz-feldspar-rich sedimentary rocks (sandstone, greywacke etc.) and igneous rocks (granite, granodiorite etc.). Processed granitic rocks and hard sedimentary rocks such as greywacke and hard sandstone are widely used by the construction industry as construction aggregate (UOA, 2005) and at present, are the source of most of Sweden's construction aggregate (SGU, 2015). However, their use as a construction aggregate depends upon several strength characteristics such as brittleness and resistance to abrasion as well as other chemical properties such as the level of gamma radiation (a natural occurrence in granite) (SGU, 2015). SGU has a publicly available Rock Quality Map with analyses of over 1,500 samples of rocks collected throughout Sweden, which is constantly being updated. However, given the regional level of this study, and the lack of detailed geological and geotechnical information for the particular developments sites (with such information usually obtained following site specific ground investigation at the early design stages of development projects), rock identified within the Quaternary soil maps, when excavated, is assumed to be a granular arising with 100% reusability as a recycled CDW aggregate. This does not account for various degrees of weathering that may classify some of the excavated rock as unsuitable for use as a construction aggregate. However, over estimation of excavated rock suitable as a construction aggregate under this assumption is somewhat offset by the omission of rock encountered below the shallow soil cover during excavation, unidentified from the Quaternary soil maps (section 2.1.1.3.5).

Regarding the soil types encountered, postglacial and glacial sands and gravels are typically clean granular soils (i.e. low percentage of fines) (Mácsik, 2015) and therefore are assumed to be 100% reusable. Sandy moraine is the most common till encountered in the Study Area. Till is typically characterised as comprising a mix of soil types ranging from finer particles such as clays and silts up to boulder sized particles (>200mm). 30% of the till is assumed to comprise cobbles and boulders that can easily be sorted on site and both processed and reused on site or transported to a material bank for processing and subsequent recycling. The remaining 70% is assumed to comprise a cohesive mixed soil that can be reused on site as general filling material or disposed of either through spreading within the site boundaries or taken to a designated receptor facility. This assumption has been based on typical particle size distributions of tills described in Avén, 1984 and confirmed with a local engineering geologist (Mácsik, 2015).

Backfilled Materials

The backfilled materials that are to be included in the material flow analysis are construction aggregates (crushed rocks and natural sands and gravels) used as both general and structural filling materials as well as cohesive soils for general backfilling purposes only (section 1.4.5.2). The cohesive soils to be used are assumed to comprise site-won cohesive soils. Common cohesive soils encountered within the Study Area are glacial and post-glacial clays and silts along with cohesive till.

2.1.1.4 Other Variables in the ESAR Model

Other variables beyond the main inputs described in section 2.1.1.1 were also required model inputs. Such variables included average residential building areas (used to determine an excavation factor), excavation depths for basement structures, number of car park spaces per apartment, net living area per person, number of persons per apartment and ratio of gross to net living area (Israelsson, 2014). However, given the lack of detailed development information available at the regional planning level with regards to residential building areas, excavation depths and number of car park spaces, standard values were used based on previous work carried out by Israelsson (2014), taking the Annedal residential area in Stockholm to represent a typical residential area, along with statistical values for living areas and persons per household previously collected by Israelsson (2014).

Once the main variables for the ESAR Model were obtained from the interpretation of MCPs and soil maps, the variables were input into the model together with the standard values for the other variables to obtain estimations for the quantities of soil and rock generated from development areas and quantities of backfilling materials required by those areas.

2.1.1.5 Modification of ESAR Model Output for Material Flow Analysis

2.1.1.5.1 Bulked Masses for Transportation

The model output for excavated materials and required materials are un-bulked; i.e. excavated materials are burrowed volumes and required materials are compacted volumes. As the focus of this study is on the transportation of these materials, bulking factors were applied to the excavated materials as they would be transported in a loose state. To determine the volume of required materials in their loose state, typical compacted densities of materials were divided by their loose bulk densities to obtain a shrinkage factor. Required volumes were then multiplied by this shrinkage factor to obtain the total required loose volumes of materials. The bulking and shrinkage factors used are presented in Table 5.

Table 5: Bulking and Shrinkage Factors for Materials

Material	Avg. Burrow Density x10^3 (kg/m^3)	Bulking Factor	Bulk Density (Loose) x10^3 (kg/m^3)	Avg. Compacted Density x10^3 (kg/m^3)	Shrinkage Factor	References
Granites/ Greywacke/ Sandstone	2.7	1.775	1.52	1.95	1.28	(The Engineering Toolbox, 2015, Geoguide 1, 2000)
Gravel/Sand	1.84	1.25	1.47	1.84	1.25	(The Engineering Toolbox, 2015, Geoguide 1, 2000)
Clay/Silt	2.2	1.3	1.69	N/A	N/A	(The Engineering Toolbox, 2015, Geoguide 1, 2000)
Till/ General Backfill/ Embankment Fill	2.02	1.275	1.58	2.00	1.26	(The Engineering Toolbox, 2015, Geoguide 1, 2000)

The materials were then converted into their masses by simply multiplying the bulk volumes by their bulk densities. Masses are used rather than volume as the weight is often the limiting factor for the loading capacity of HGVs when transporting bulk material with high densities such as soil and rock (Stripple, 2001).

2.1.1.5.2 Material Balance

As mentioned previously in section 1.1.2, due to constraints such as available space (particularly in built-up urban areas), much of the material that would otherwise be useful as backfilling material is often exported from construction sites (Magnusson, 2015). However, a certain amount of site reuse will be carried out. For the purpose of this study, general backfill demand is assumed to be completely satisfied by excavated (site-won) materials primarily in the form of cohesive soil (section 1.4.5 and Figure 8). In the event of a shortage of cohesive materials, granular arisings will be substituted.

For simplification purposes, a reuse percentage of 15% has been assumed for granular arisings to satisfy the structural fill requirements for all developments. This initial assumption was made as a significant proportion of developments in the Study Area are related to densification of built up areas and as such, the amount of space available on site would be limited for sorting and processing granular arisings. This percentage of reuse was incorporated into the material balance as a variable and can thus be adjusted to individual sites as more information about the developments arises.

The ESAR model has differentiated between crushed rock and natural sands and gravels as two separate structural backfilling materials (Israelsson, 2014). To simplify the material demand, crushed rock and natural sands and gravels have been grouped into the same material category: Aggregates. This is done because natural sands and gravels can be completely substituted by crushed rock (SGU, 2015), a common practice today in Sweden and in-line with Sweden's natural resource strategy (section 1.1.2).

The model inputs together with the model outputs and material balances have been extracted and are presented in Appendix 4.

2.1.2 Cross-Connection Södertörn

The Cross-Connection Södertörn has been included within Stockholm's Regional Development Plan (TRF, 2010) and is intended to form the southern portion of the outer cross-connection route forming a connecting road across Södertörn between the NR73 and the E4/E20 (Figure 10).

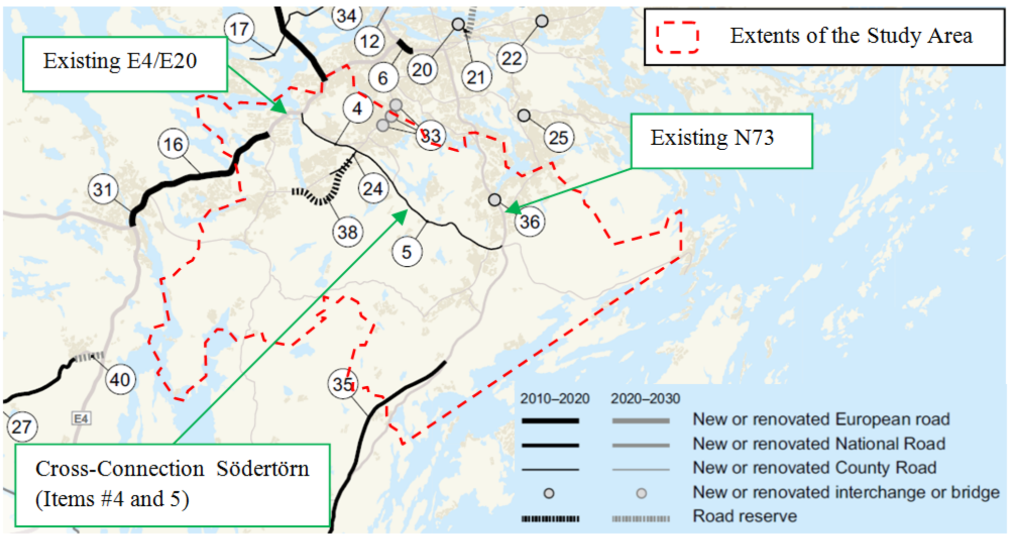


Figure 10: Location of Cross-Connection Södertörn within the Study Area.
(Background Image Extracted from RUFS TRF, 2010)

Cross-Connection Södertörn is currently in the planning stages with an anticipated construction start date as early as 2020 (Trafikverket, 2015a). This is a regional infrastructure project that spans across two of the municipalities within the Study Area; Huddinge and Haninge. Given the extent of the project, its location within the Study Area and its construction start date anticipated within the study's time horizon (2016-2030), it is likely to contribute a significant amount of material to the material flow analysis for the Study Area and as such, this infrastructure project has been included into the study.

2.1.2.1 Data Collection Sources

2.1.2.1.1 Road Geometries

In the 1990s and early 2000s feasibility studies were undertaken for Cross-Connection Södertörn (formerly Södertörnsleden) (Larsson, Öhman, Tyréns AB, 2015). The study areas were split into sections as shown in Figure 11.

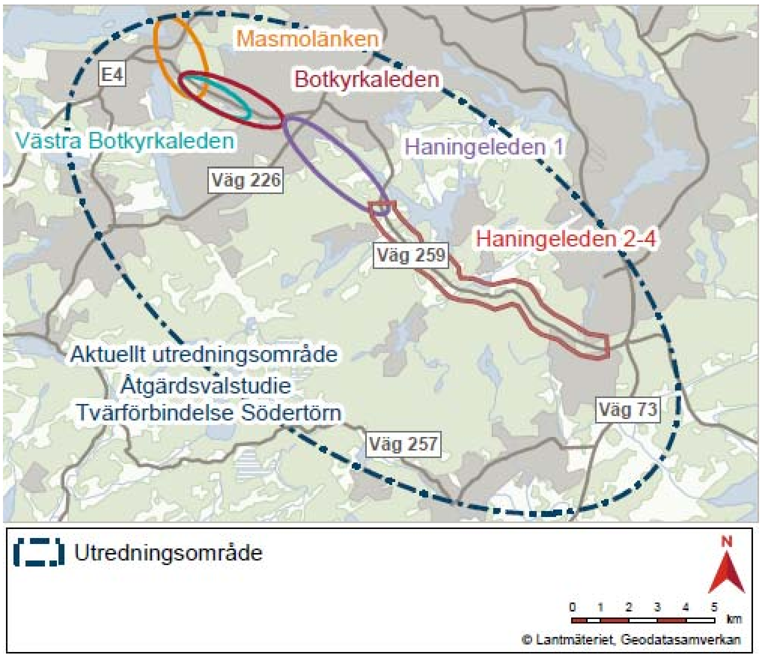


Figure 11: Previous Study Areas for Södertörnsleden.
(Larsson, Öhman, Tyréns AB, 2015)

Cross-Connection Södertörn had undergone preliminary alignment design for the separate study areas presented in Figure 11. These preliminary alignment plan and profiles were archived and are available online from the Swedish Transport Administration's website (Trafikverket, 2015b, Trafikverket, 2015c, Trafikverket, 2015d). New legislation and regulatory changes led to the Swedish Transport Administration reconsidering the previous work undertaken for Södertörnsleden with a new holistic approach (Larsson, Öhman, Tyréns AB, 2015). Given the level of detail from the preliminary alignment drawings available for the original Södertörnsleden and little current knowledge about the renamed Cross-Connection Södertörn, an assumption has been made for the purposes of this study in that the vertical and horizontal alignments will not deviate significantly from the original plans with key structural elements remaining as well (tunnels, junctions and road widening sections). Thus, the available archived data has been used to estimate earthworks quantities.

For typical road geometries, Swedish Transport Authority Road Design Standards have been used (Trafikverket, 2012). Typical geometries for road tunnels have been referenced from the Norwegian Public Roads Administration's Standard for Road Tunnels (Statens Vegvesen, 2004). Typical pavement layer thicknesses (sub-base to top of pavement) were obtained from the Construction Handbook for Roads and Water Construction (Avén, 1985).

2.1.2.1.2 Geology

In order to obtain an estimation of the material types being excavated, geological information along the road alignment is required. For this, Quaternary deposit maps were acquired from SGU.

A summary of the information extracted from various sources to estimate earthworks quantities and types (including pavement) quantities is presented in Table 6.

Table 6: Data Sources for Estimating Earthworks Quantities for Cross-Connection Södertörn.

Source	Available Information	Reference
Swedish Road Design Standards	<u>Road Geometry</u> Widths of: lanes, central reserve, hard strip, hard shoulder, verges, embankment side slope gradient.	(Trafikverket, 2012)
Norwegian Road Tunnel Design Standard	<u>Road Tunnel Geometry</u> Tunnel cross-sectional area (for two-lane tunnels, type T9.5)	(Statens Vegvesen, 2004)
Construction Handbook for Roads and Water Construction	<u>Road Geometry</u> Pavement thicknesses including sub-base for asphalt concrete pavement	(Avén, 1985)
Plan and Profile Drawings	<u>Road Geometry</u> Number of lanes <u>Vertical Alignment</u> At-grade portions and heights of embankments and cuttings <u>Road Features</u> Tunnels, junctions and slip roads, structures etc. <u>Geology</u> Depth to bedrock from longitudinal cross-sections	(Trafikverket, 2015b, Trafikverket, 2015c, Trafikverket, 2015d)
Quaternary Soil Maps	<u>Geology</u> Soil and rock types encountered along the road alignment	(SGU, 2015)

2.1.2.2 Data Interpretation

The ESAR model has been constructed to incorporate road infrastructure projects. However, given the scale and various likely construction elements that will generate and require significantly different quantities of earthworks such as tunnels, grade-separated junctions and road-widening, it was decided early on in the study not to use the oversimplified ESAR model assumptions for this road project and rather utilize the more detailed information to estimate material quantities.

A bespoke spreadsheet was constructed whereby variables for road geometry and elevation could be input to estimate earthworks quantities. The alignment was split up into chainages based on the road elements encountered. The elements were split into five categories; tunnel, embankment, at-grade (±1m above existing ground level), cutting and road widening.

2.1.2.2.1 Tunnels

The Masmolänken section of the Cross-Connection Södertörn comprises a north and southbound tunnel each approximately 1km in length. Typical two-lane road tunnel geometries have been used to estimate volumes of excavated materials. The Norwegian Road Tunnel Design Standard has been used as a reference with cross-sectional areas for the tunnels given in the manual. From geological maps, the tunnels pass predominantly through rock with a zone of glacial sand and gravel encountered approximately midway of the tunnels over a distance of 100m. As such, the majority of the tunnel is assumed to be constructed with a drill and blast method. Rock mass variables and construction variables can lead to varying amounts of over break during tunnel construction and a tunnel over break of 10% has been assumed (Mahtab et al., 1997).

2.1.2.2.2 At-Grade, Embankments and Cuttings

At-grade has been defined in the earthworks spreadsheet as sections of the road that are within 1m above or below the existing ground level. At-grade portions of the road are assumed to require a nominal 1m excavation for replacement of the sub-grade materials with embankment and pavement layers of sufficient strength (Avén, 1985).

Sections of the road where the vertical alignment is over 1m have been grouped into “embankments”. For these sections, the embankment widths at the base of the embankments have been determined based on typical embankment side slopes of 1:2 (vertical to horizontal, 1V:2H). Together with the road width at the pavement level (determined from the typical road geometry, Trafikverket, 2012), and typical embankment construction materials, the total volume and type of earthworks materials can be estimated.

Where the road elevation is 1m below the exiting ground level, the road has been grouped into “cuttings”. The cutting (and embankment) side slope gradients are variables that can be input into the spreadsheet. Side slopes of 1V:1H have been assumed within rock and 1V:2H within soils. With the road width at the pavement level known, together with the exiting ground level and approximate bedrock elevation, the volume and quantities earthworks materials can be estimated.

2.1.2.2.3 Road Widening

Under the previous design of Södertörnsleden, road widening is to take place over the majority of the Haningeleden 2-4 road section where the existing R259 is to be widened to a 2+1 road. Although this is likely to be increased to a 2+2 road in the revised design (Larsson, Öhman, Tyréns AB, 2015), as no information is available on this new layout, the previous design for the road widening to a 2+1 is adopted for this study.

Road widening is assumed to take place on one side of the existing road. The existing road width is known along with the typical road width of 2+1 roads from the Swedish Road Design Standards (Trafikverket, 2012). Other assumptions included an additional excavation width of 1m to allow for interlocking between the existing road and the adjacent earthworks for the road widening, and a pavement overlay over the entire road width.

2.1.2.2.4 Bridge Structures and Other Road Features

Earthworks associated with the foundations of bridge structures have been omitted from this analysis. As the estimated earthworks volumes up to bridge abutments or box structures has been included in the spreadsheet, any additional earthworks materials would arise from the excavation for the foundations of the bridge structures and backfilling activities. The total road length is estimated to be approximately 20km and the earthworks quantities associated with bridge foundations is assumed to be a small quantity when considering the total length of this project.

Possible locations of earth retaining structures (retaining walls) that run along the road alignment have been identified from the plan drawings, along with areas of relaxed embankment side slopes, widened central reserves and widened verges. As the embankment side slopes and road geometry are input variables in the spreadsheet, these features have been included in the earthworks quantities estimation.

2.1.2.2.5 Road Foundations for Embankments

Additional sub-grade excavation has been assumed where road embankments are over clays/silts. The depth of the additional sub-grade excavation has been limited to 1m assuming that areas of extensive soft ground will be treated using ground improvement techniques (such as prefabricated vertical drains), resulting in nominal excavation of in-situ soils.

2.1.2.2.6 Road Pavement

The road pavement is assumed to be asphalt concrete. Thicknesses of pavement layers have been taken from Avén 1985 selecting an average pavement class of 5 (Trafikklass 5, Avén 1985). The percentage of aggregates assumed in asphalt concrete is 85% of the total volume (MCHW, 2009a).

The plans and profiles of Södertörnsleden used for the estimation of soil and rock quantities for Cross-Connection Södertörn have been attached in Appendix 5.

2.1.2.2.7 Construction Timeline

Construction of Cross-Connection Södertörn is anticipated to commence in 2020 and be open to traffic by 2025 (Trafikverket, 2015a). The assumption is that the construction is carried out at an even rate simultaneously along the entire route. This assumption is made as the contract procurement method and phasing of the works is unknown. Earthworks typically commences shortly after the construction commences and peaks towards the middle of the construction duration. As pavement is also included in the materials inventory and is usually carried out at the later stages of construction, a fairly even distribution of the earthworks intensity is assumed. With five years of construction from the commencement in 2020 to the completion at the end of 2024, the earthworks intensity has been split-up as 20%-25%-25%-20%-10% for the five years running from the beginning of 2020 to the end of 2014 respectively.

2.1.2.2.8 Materials

Excavated material types encountered along the alignment are identical to those for the building developments within the Study Area. The groupings of these excavated materials follow the same grouping as that for building developments (section 2.1.1.3.6).

Filling materials for road infrastructure have been categorized into general embankment filling materials and aggregates (crushed rock). General embankment filling materials are used for embankment layers between the sub-grade or any granular basal layer and the pavement layers (including the sub-base). Site-won materials that are most commonly used as general embankment filling materials include crushed rock, natural sands and gravels and till (Mácsik, 2015). Crushed rock is typically used to construct the sub-base and is the common aggregate used in cement bound pavement layers (MCHW, 2009a). Crushed rock is also used for a variety of purposes beyond pavement layers such as at the location of structures as structural backfill to abutments, granular pedestals for structural foundations, at the base of embankments for basal drainage layers etc (MCHW, 2009b). Nevertheless, for the purposes of simplification, crushed rock demand is assumed to be from the pavement layers (and in the case of at-grade construction, for the entire road construction) and general embankment fill is assumed to be from crushed rock, sands and gravels and site-won till.

2.1.2.2.9 Material Balance

The processing and reuse of site won material is a priority on all construction projects and with road projects, the possibility of reuse is higher within their site boundaries than for development projects with less available working space. A site reuse of 50% has been assumed for the Cross-Connection Södertörn. Similarly to the building development material balance, the site reuse percentage is a variable that can be modified should specific reuse goals be set for development projects.

Earthworks volumes were converted into loose bulk volumes for the transportation analysis using the same method described in section 2.1.1.5.1. Similarly, to the building development material balance, general embankment fill will be first satisfied by site-won till and subsequently by site-won granular arisings. For required materials, crushed rock and natural sands and gravels have been grouped into required aggregates and it is assumed that till from other development projects and/or material banks will not be delivered to the road project. Thus, any shortfalls in site-won materials for the general embankment fill are to be made-up from imported aggregates.

Screenshots of the bespoke spreadsheet are presented in Appendix 6. The material quantities from Cross-Connection Södertörn have been combined with the building development material quantities and the material balance is presented as an add-on to the ESAR model output in Appendix 4.

2.2 Strategically Locating Material Banks

2.2.1 Existing Material Banks

Prior to strategically locating material banks, it is important to identify existing material banks as these banks will form the basis for the business-as-usual scenario. This, in turn, will be used as a comparison to the scenario of strategically located material banks to quantify the environmental benefits between the two scenarios. Existing material banks and quarries which also dual as material storage areas have been plotted together with the development locations within the Study Area using GIS software ArcMap (Figure 12).

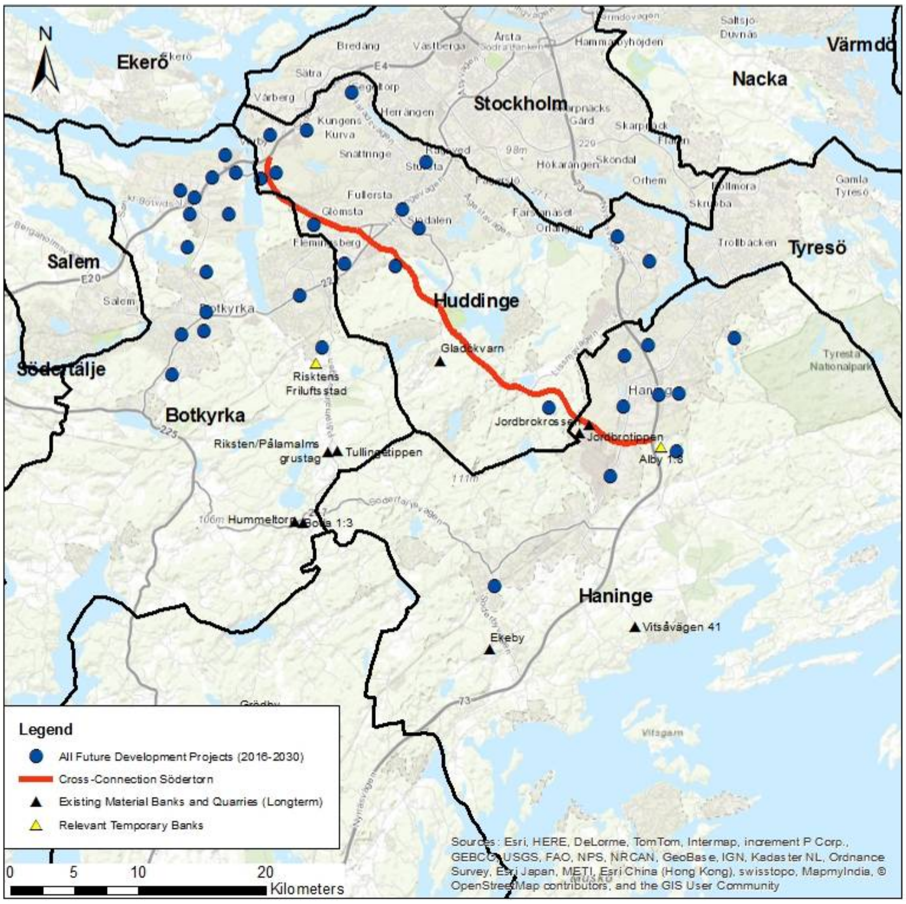


Figure 12: Existing Material Banks and Quarries Within and Immediately Surrounding the Study Area.

As can be seen in Figure 12, existing material banks are generally located outside of the development areas in Botkyrka and in northwest Huddinge whereas to the east of the Study Area, there are centrally located existing material banks (Jordbrokrossen and Jordbrotippen, a quarry and a material bank) for developments within the north of Haninge and the southeast of Huddinge.

2.2.1.1 Consideration of Temporary Existing Material Banks

Temporary material banks have been identified within the Study Area. However, the duration that these material banks will remain operational is limited, and unless they have been specifically located for a future development project, they have been assumed not to be operational under the two scenarios. In the case of specifically located material banks, only two temporary material banks; Rikstens Frilufts stads and Alby 1:8 had been identified that have been established for specific development projects: Rikstens Business Park and Albyberg Industrial Park (shown on Figure 12). These temporary material banks are assumed to only handle material flows for those specific developments and no other surrounding developments.

2.2.2 Steps for Strategically Locating a Material Bank

To strategically locate material banks, a visual based method utilising GIS software ArcMap was adopted. The following steps were carried out to strategically locate material banks.

Step 1 – Identify Clusters of Developments Furthest Away from Existing Material Banks

Existing material banks together with development areas were plotted using ArcMap and a visual based method was used to identify clusters of developments furthest away from existing material banks. With centrally located material banks for the developments to the east of the Study Area, the north and northwest of the Study Area were identified as being the focal areas for maximizing environmental benefits from strategically located material banks.

Step 2 – Plot Material Flows into and out of Development Projects

Once the material balance had been carried out for each individual development area, the net demand and supply of material quantities flowing into and out of each development area were plotted. From the plot, areas where there was a concentration of larger material flows could be identified. These areas are of most interest as they would carry a larger weighting of the total material transportation distances (tonne-kilometres) within the Study Area, and hence strategically locating a material bank close to these areas would be most beneficial from an environmental (and likely economical) perspective.

Step 3 – Overlay Degrees of Availability GIS Map Layers

The next step was to identify potential material bank locations central to the larger concentrations of material flows. This was done by overlaying the "Degrees of Availability" map layers in ArcMap previously developed by Morén (2015) (introduced in section 1.1.5.2).

Preference was given to areas with high availability followed by moderate availability with areas of low availability and very low availability ignored. Each individual potential location was looked at in further detail using the topographical basemap layer to confirm that the areas did not clash with existing developments, had access to a nearby road and to measure the potential area for the strategically located material bank.

2.2.3 Transportation Routes to and from Existing and Strategically Located Material Banks

Once the potential sites had been identified, transportation distances between development areas and existing as well as strategic banks were collected.

2.2.3.1 Business as Usual Scenario – Utilisation of Existing Material Banks

The responsibility of materials management is often placed onto the Contractor who in many cases may have their own construction aggregate supply sources (Magnusson et al., 2015). With economics often being the deciding factor in the sourcing of and recycling of construction materials for a project, the nearest material bank may not necessarily be the supplier and receiver of these materials. Therefore, under the business-as-usual scenario, whereby materials flow to and from development areas from existing material banks, a 70/30 proportion of material flows have been assigned to the nearest and second nearest material banks respectively.

2.2.3.2 Strategic Material Banks Scenario

Under the strategic material bank scenario, both strategic material banks and existing material banks are optional locations for material to be transported to and sourced from. This is based on the assumption that existing material banks would remain open in conjunction with new strategically located material banks. This assumption conforms with the general opinion of key players in the materials management industry that have mentioned that there is currently a shortage of material banks (Morén, 2015) as well as RUFS 2010, that has highlighted the need to identify and safeguard areas for the establishment of aggregate banks (TRF, 2010).

Where material transportation distances are closer to strategic material banks than to existing material banks, 100% of the granular arisings and recycled aggregates are assumed to be delivered to and from the strategic material banks. This assumption is based on a regional approach to materials management whereby projects would be incentivised or contractually obliged to utilize regionally established strategic material banks.

2.2.3.3 Transportation Route Data Collection

Sweden's roads are classified into bearing capacity classes; BK1, BK2 and BK3 where each class allows different vehicle weights and dimensions. BK1 permits the largest/heaviest vehicles with BK2 being somewhat more restrictive and BK3 the most restrictive. It is predominantly BK1-rated roads that are suitable for heavy goods vehicles (HGVs) and these represent approximately 95% of Sweden's public road network BK1-rated (Morén, 2015). With such a high percentage, it is assumed that the majority of roads in the Study Area are BK1 roads.

Initially, the route analysis was intended to be done using the Closest Facility tool in the Transport Analysis extension within ArcMap. However, network data could not be retrieved and built within the time frame for the study. As such, it was decided to use Google Maps' Directions tool to collect data on travel distances between the material banks and the development areas (Google Maps, 2015). The average distance going to and coming from the material banks were recorded for each development area as one way distances would not represent the true travel distances for a distribution lorry (i.e. a distribution lorry takes a material load from a development area to a material bank and returns to the development area). All recorded distances were double checked to reduce the possibility of manual errors.

2.2.4 Assigning Material Banks to Development Areas

Once the distances between the material banks and the development areas were collected, they were tabulated and the optimal material bank was identified for each development area (the optimal material bank being the one with the shortest transportation distances). This enabled the identification of the development areas that would have their material flows directed towards strategically located banks and facilitate the comparison of transportation related GHG emissions between the two scenarios over the entire Study Area.

2.2.5 Selecting Strategically Located Material Banks

With the developments and strategic material banks paired, a selection of the bank or banks to be utilised under the strategically located material banks scenario was made. This was carried out using a weighted scoring method, whereby development areas were assigned a weighting factor based on estimated material quantities entering and leaving those development areas as a proportion of the total estimated material quantities entering and leaving all development areas within the Study Area. This would then be multiplied by the distances to and from material banks to identify optimal material banks - those having the lowest vehicle-kilometres. The formulas used for the weighted scoring method are summarised in equations 1 to 3 below:

$$\textit{Material weighting for each development area} = \frac{\textit{Material in to development area}}{\textit{Total material in to all development areas}} + \frac{\textit{Material out of development area}}{\textit{Total material out of all development areas}} \quad \text{(Eq. 1)}$$

$$\textit{Weighting score for each development area} = \textit{Material weighting for each development area} \times \textit{Material transportation distance} \quad \text{(Eq. 2)}$$

$$\textit{Strategically Located Material Bank Weighted Score} = \sum \textit{Weighting score for each development area} \quad \text{(Eq. 3)}$$

Combinations of banks were then further examined to see the aggregated benefits of using multiple banks.

2.2.5.1 A Check of Material Flows into and out of the Selected Material Banks

The final step was to check the material flow into and out of the strategically located material bank over the study time horizon. This is an important step because if the recycled aggregate demand exceeds the supply, the aggregate would be required to be imported from elsewhere thus reducing the overall environmental (and likely economical) benefit from the strategically located material bank. Additionally, checking material balances within strategic material banks over time can help to highlight any potential for utilising surplus recycled aggregates in other applications such as recycled aggregate for concrete.

2.3 GHG Emissions from Transportation

Greenhouse gas emissions from transportation sources include CO_2, CH_4, N_2O, and various HFCs. CO_2, CH_4 and N_2O are all emitted through the combustion of fuels (direct emissions), with HFCs related to refrigerants used to cool the internal vehicle environment (fugitive emissions, Defra et al., 2009). The extraction, refining and transportation of the oil itself will also involve the emission of GHGs (pre-combustion or "well-to-tank" emissions). These are categorised as indirect emissions (Defra et al., 2009).

The fuel to be combusted is assumed to be 100% mineral diesel oil under both scenarios - a common fuel for heavy goods vehicles (HGVs) used to transport aggregates (Defra et al., 2009). The pre-combustion emissions for diesel oil vary between different studies (Stripple, 2001, Eriksson and Ahlgren, 2013) with pre-combustion CO_2 emissions representing a typical range of between 4-13% of combustion emissions in Sweden.

Stripple (2001) carried out one of the first LCAs for an entire road construction project in Sweden. Although somewhat dated, his inventory has been selected as the inventory is most relevant to Sweden. The data provided by the inventory includes emissions for GHGs in vehicle-kilometres for a 14T distribution lorry (HGV) based on maximum load out and empty on return. Stripple (2001) also acknowledges the questionable reliability of pre-combustion emissions. Nevertheless, the pre-combustion emissions presented in Stripple (2001) have been adopted for this study. The inventory data used to perform the GHG emission calculations are presented in Tables 7 and 8.

Table 7: Fuel Consumption Data for a 14T Distribution Lorry

HGV Load	14	Tonnes
Fuel Consumption (max. load)	0.39	l/vkm
Fuel Consumption (Empty)	0.29	l/vkm
Fuel Consumption (max. load empty on return)	0.34	l/vkm
Energy (max. load empty on return)	11.9	MJ/vkm

Table 8: Inventory Data for Distribution Lorry and Diesel Combustion Emissions. (Stripple, 2001)

	Unit	Flow per MJ used diesel, distribution truck	Pre-combustion addition per MJ used diesel	Total Flow, distribution truck per vehicle-kilometre (Maximum load out, empty on return)
Oil	MJ	1	0.1	13.1
CO_2	g	75	4	943
CH_4	g	0.00005		0.000597
N_2O	g	0.0016		0.0191

To obtain total vehicle-kilometres for each development area, the quantities of material flows going out from and coming into each development were divided by the HGV maximum load and then multiplied by two to account for the empty return journey. By multiplying the vehicle-kilometres by the quantities of GHGs (CO_2, CH_4 and N_2O) per vehicle-kilometre (given in Table 8), the total quantity of GHGs were obtained for each development. The GHGs were then converted into CO_2e using the latest conversion factors from the IPCC's Fifth Assessment Report (AR5) (Shindell et al., 2013). Finally, total CO_2e emissions compared between the Business As Usual scenario and the Strategic Material Banks scenario for the entire Study Area for both material outflows (granular arisings), inflows (recycled aggregates) and total (in and out flows). The outflows would be from excavation activities that would occur under both scenarios and therefore any potential CO_2e savings in outflows would represent the nominal potential environmental benefit. Imported aggregates may come from primary or recycled sources. Inflows of construction aggregates coming from material banks assume 100% use of recycled aggregates for construction activities within the study. Including the CO_2e savings from these inflows represents a theoretical maximum potential environmental benefit within the boundaries of this study.

3 Outputs from Key Stages of the Study

This section presents the outputs from the key stages in the study with a logical progression towards the final result. Tabulated outputs from the estimation of soil and rock quantities from building development projects and the Cross-Connection Södertörn within the Study Area along with data extracted from MCPs and Geological maps have been discussed in the Methodology section and are attached in the Appendices. Results from each of the steps for strategically locating material banks (section 2.2.2) will be presented, together with the selection of strategic material banks, the material flow analysis for the identified strategic material banks and a summary table of the potential environmental benefits from strategically located material banks.

3.1 Strategically Locating Material Banks

3.1.1 Identifying Clusters of Developments Furthest Away from Existing Material Banks

The development areas within the three municipalities; Botkyrka, Huddinge and Haninge, were plotted using ArcMap together with existing material banks to identify clusters of development areas that were located furthest away from existing material banks (Figure 13).

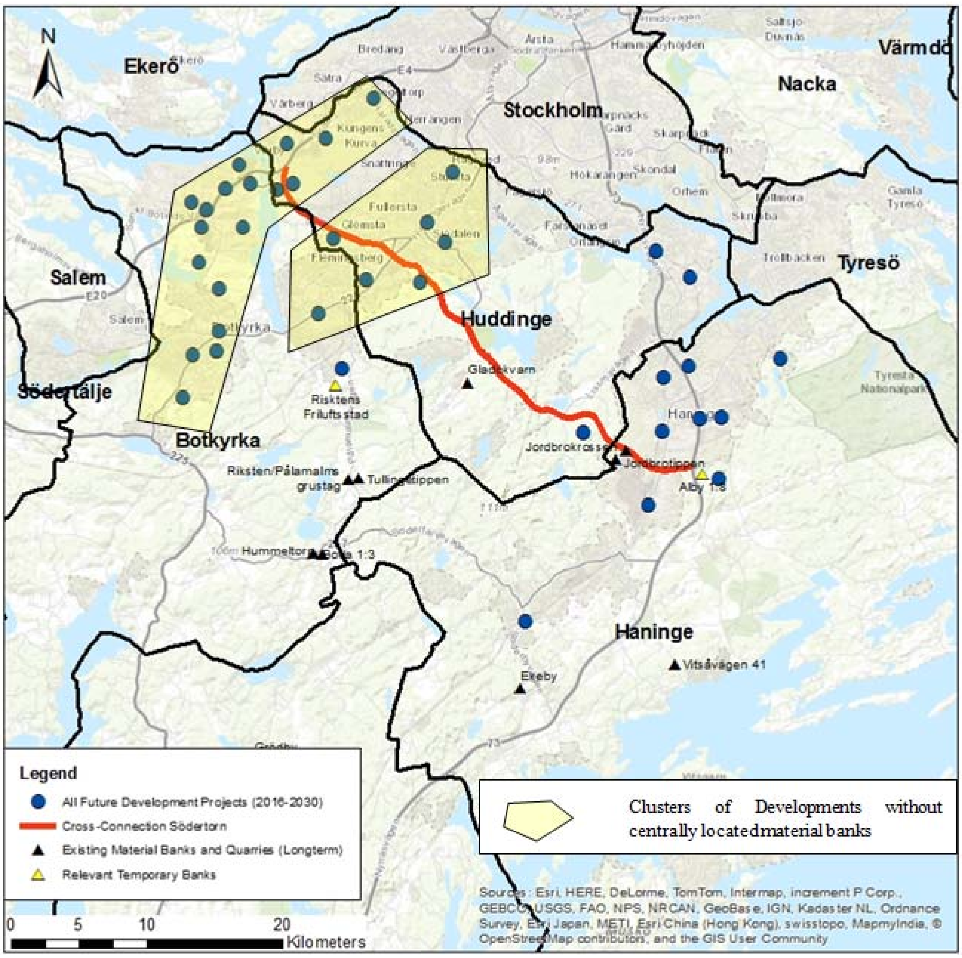


Figure 13: Location of Development Areas and Existing Material Banks.
(Clusters of development areas located furthest away from existing material banks are highlighted)

As can be seen in Figure 13, Jordbrokrossen and Jordbrotippen, a quarry and a material bank, are in relatively close proximity to developments within the north of Haninge and the southeast of Huddinge. In contrast, there is an obvious lack of centrally located material banks for developments within Botkyrka and the northwest of Huddinge. From this step, two clusters of developments within the Study Area were identified as being the focal areas for maximizing environmental benefits from strategically located material banks.

3.1.2 Material Flows into and out from Development Areas

The total quantity of materials flowing into and out from development areas within the Study Area over the entire time horizon of the study are presented in Figure 14. These quantities have been obtained from the ESAR model outputs and the bespoke spreadsheet for Cross-Connection Södertörn (Appendices 4 and 6).

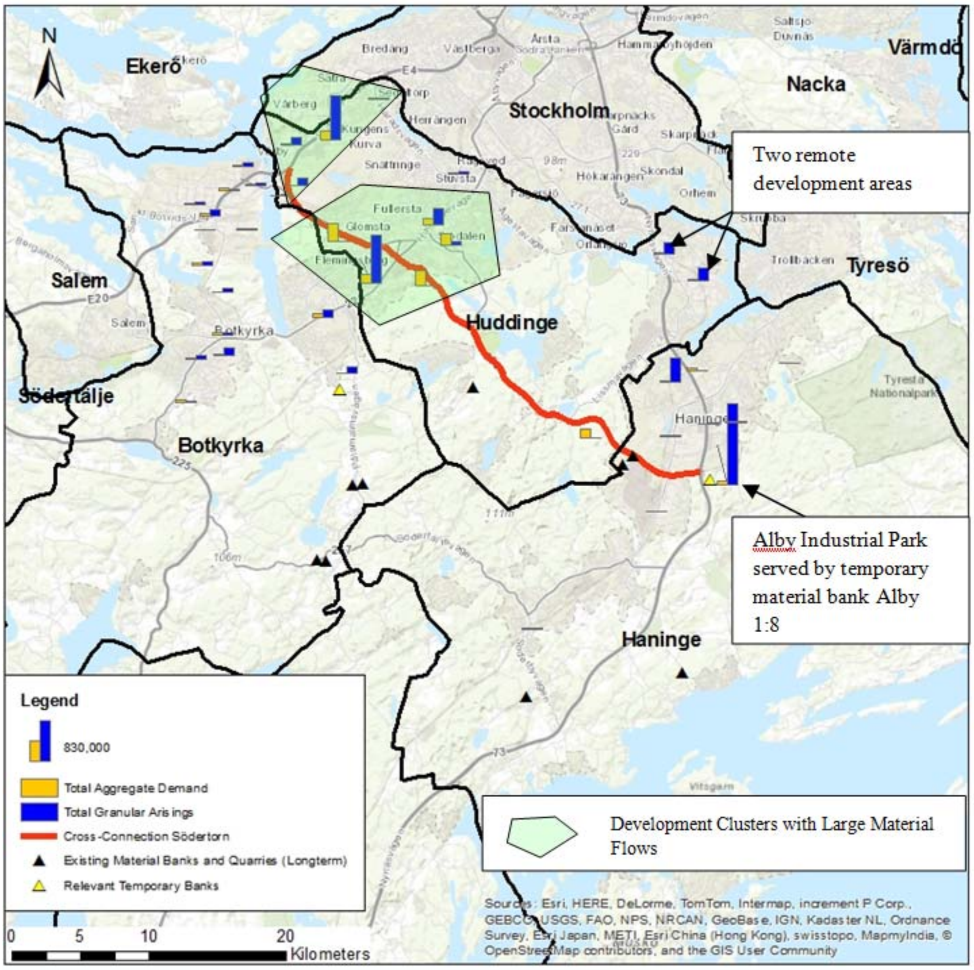


Figure 14: Total Material Flows into and out from Development Areas.

From plotting total material flows into and out from development areas, development clusters with large material flows could be identified (Figure 14). These are the areas likely to carry the largest weighting of total material flows during the time horizon and as such, were areas to initially investigate for strategically locating material banks along with the clusters identified in Figure 13. Two remote development areas (Skogås and Trångsund) with moderately large material flows were identified to the northeast of Huddinge. However, due to their more remote locations and the proximity of the existing Jordbrokrossen and Jordbrotippen material banks to adjacent developments to the south, it was decided not to consider this location for a strategic terminal site.

3.1.3 Identifying Potential Material Bank Sites

Figure 15 presents the "degrees of availability" map layers overlaid for the Study Area using ArcMap and was used to identify potential material banks sites within the areas of interest identified in Figures 13 and 14.

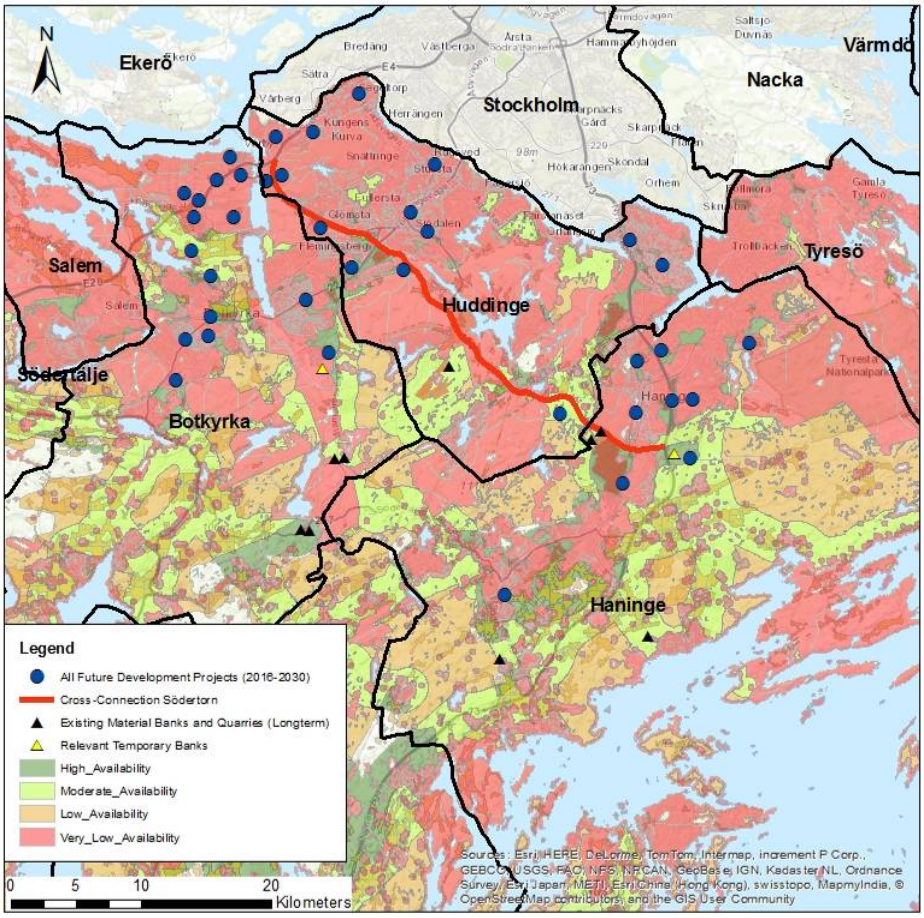


Figure 15: Degrees of Availability Overlaid with Development Areas

From Figure 15 you can see that the degree of availability generally increases southwards from the Stockholm city centre. This is in line with known materials management issues in urban areas (TRF, 2010) with this trend set to continue as densification and expansion of these urban areas continues with time (Vaivars, 2010). With lower degrees of availability in close proximity to the identified development clusters of interest, the potential locations for strategic material banks narrow down.

Initially three potential material bank sites were identified. These are presented in Figure 16.

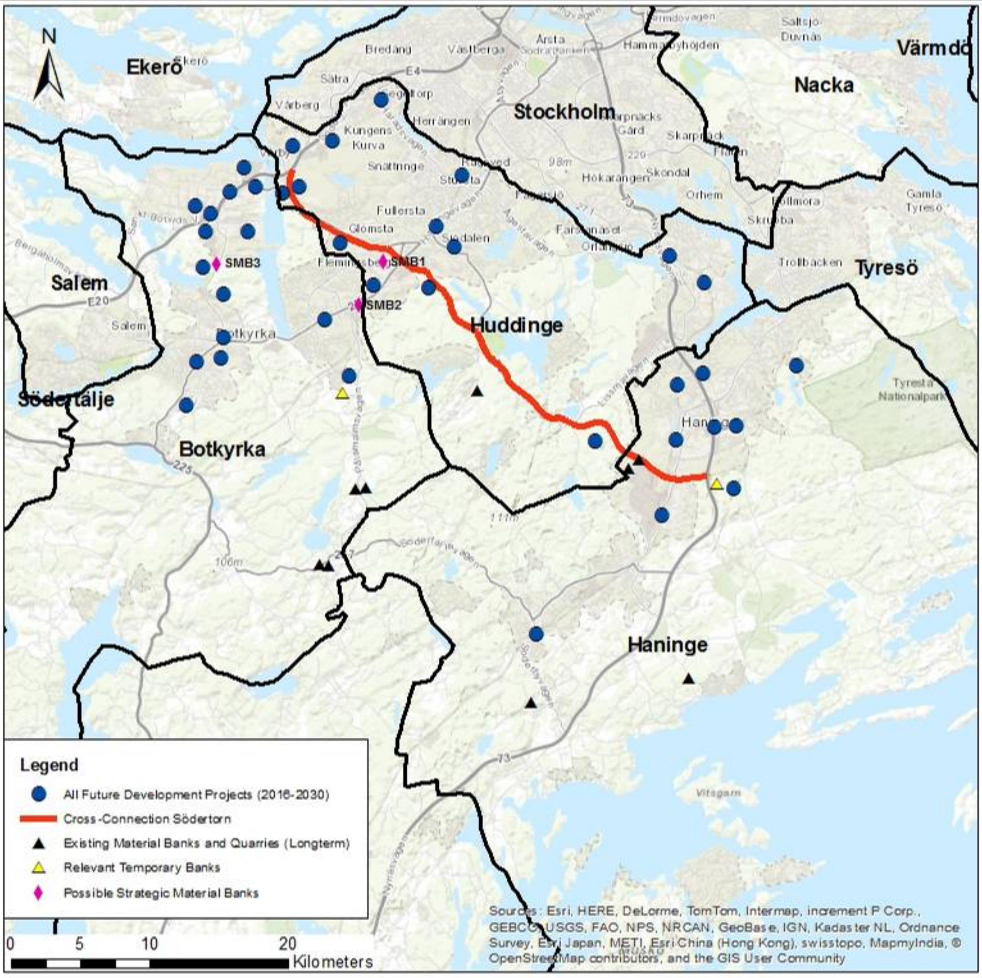


Figure 16: Possible Locations of Strategic Material Banks

Close-ups of the locations for the potential strategic material banks together with their degrees of availability are presented in Figures 17 to 22.

Figure 17: Location of Strategic Material Bank (SMB1)

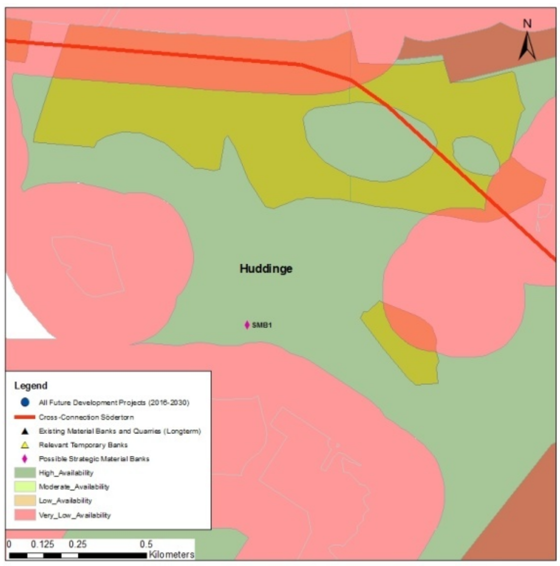


Figure 18: Degree of Availability at SMB1 Site

Figure 19: Location of SMB2

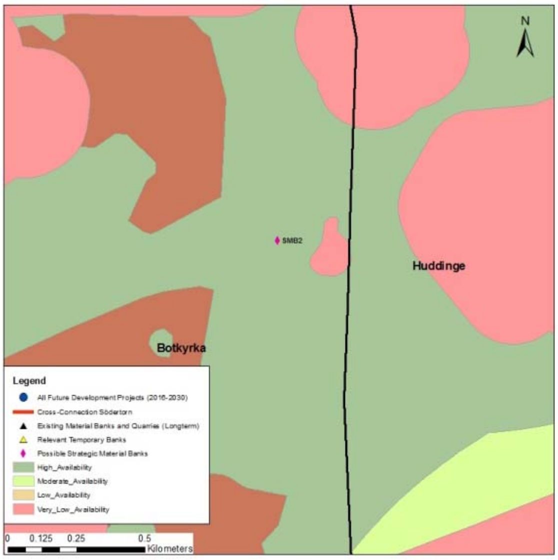


Figure 20: Degree of Availability at SMB2 Site

Figure 21: Location of SMB3

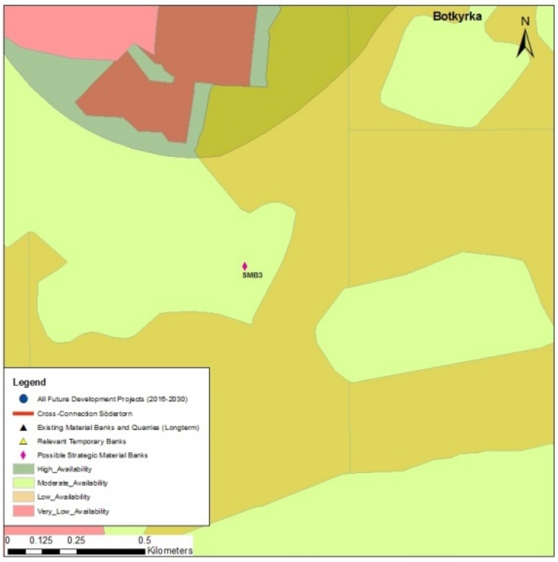


Figure 22: Degree of Availability at SMB3 Site

3.2 Selection of Material Banks

SMB1 is located to the north of Flemingsberg and is centrally located to a cluster of developments with large material flows (*Figure 14*). SMB2 is located to the south of Flemingsberg and while also close to the cluster of developments with large material flows, is not as centrally located as SMB1. SMB3 is located in a central position to multiple development areas with Botkyrka. However, the degree of availability is only moderate and SMB3 does not serve development areas with particularly large material flows within the time horizon of this study.

A weighted scoring method has been used to rank the strategically located material banks and is attached in Appendix 7. The weighted scores are presented in Table 9 with the lowest score representing the strategic bank which when combined with existing material banks, gives the lowest total vehicle-kilometres for the entire Study Area.

Table 9: Weighted Scores for Strategically Located Material Banks

Strategic Material Bank	Weighted Score	Rank
SMB1	10.32	1
SMB2	11.74	2
SMB3	16.73	3
Business-As-Usual	19.83	-

SMB1 and SMB2 are relatively closely located with SMB1 more central to the cluster of developments with high anticipated material flows identified in *Figure 14*, giving SMB1 a slightly better score. Given their close proximity, establishing two material banks at this location would not significantly reduce GHG emissions from material transportation within the Study Area. As such SMB1 is preferred over SMB2. SMB3 reduces transportation distances for clusters of development areas with lower anticipated material flows (*Figure 14*), and therefore, does not achieve as low a weighted score as SMB1 and SMB2. The weighted score for SMB1 is significantly better compared to the Business-as-usual scenario than for SMB3. Furthermore, the SMB1 reduces the haulage distances of materials for the most number of developments within the Study Area, with development areas benefiting from SMB3 also benefiting from SMB1. The number of development areas with shortened haulage distances to and from SMB1 is highlighted in Figure 23.

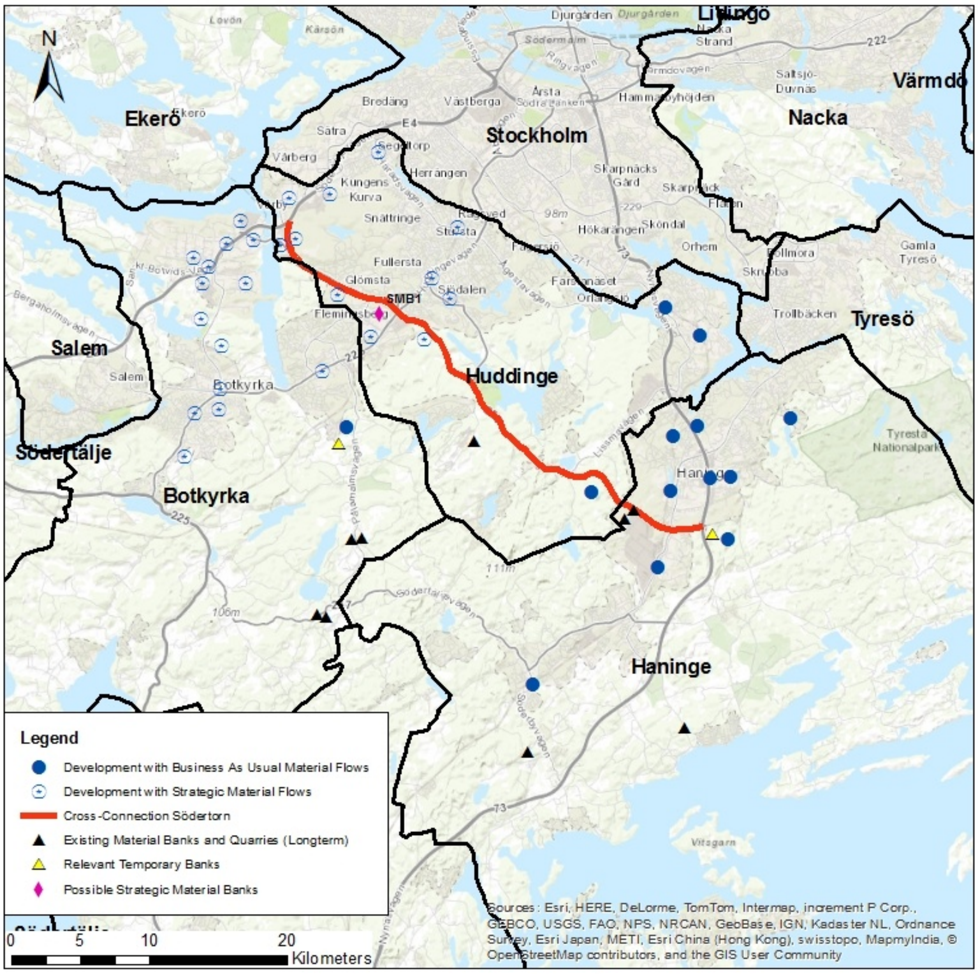


Figure 23: Developments with Reduced Material Transportation Distances from SMB1

Given the weighted scoring for the banks together with the site availability and proximity to developments with high anticipated material flows, SMB1 was selected as a standalone material bank to consider under the Strategically Located Material Banks scenario. Additional consideration has also been made for the establishment of two material banks; SMB1 and SMB3 to investigate the potential aggregated reductions in GHG emissions from reduced vehicle-kilometres.

3.3 Material Flow Analysis

3.3.1 SMB1 Only

The material flowing into and out from SMB1 from the construction activities within the study boundary have been plotted over the study time horizon and is presented in Figure 24.

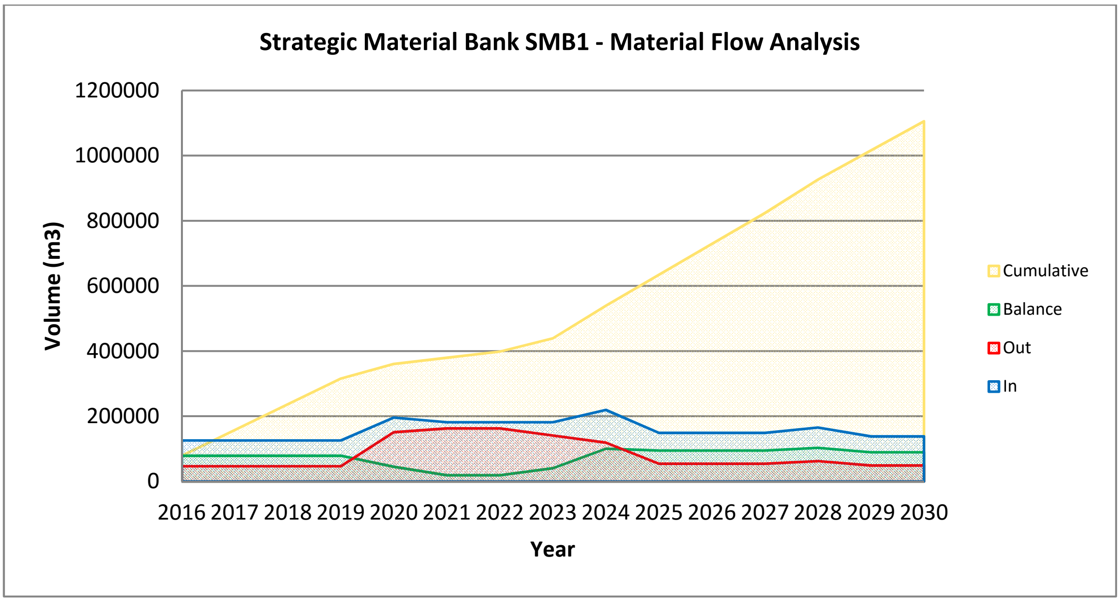


Figure 24: Estimated Material Flows into and out from SMB1 from 2016 to 2030 (SMB1 only)

The material flowing into SMB1 are the granular arisings from excavation related construction activities and the material flowing out is the recycled aggregate demand for sub-surface backfilling construction activities for building developments and road construction up to pavement level for the Cross-Connection Södertörn (assuming 100% use of recycled aggregates for these construction activities). The balance represents the annual net flow with a positive value indicating a net inflow into the bank and a negative value indicating a net outflow. The tabulated annual flows into and out from SMB1 from each development area is attached in Appendix 8.

As can be seen in Figure 24, there is a relatively steady flow of material into and out from the SMB1 from 2016 to 2019 and from 2025 to 2030. This is a result of the assumptions made for linear rates of development taking place where development timelines were unavailable within the Study Area (section 2.1.1.3.4). From 2020 to 2024 there is a rise in construction aggregate demand. This is the period during which construction of Cross-Connection Södertörn is anticipated.

The area of high availability of within the SMB1 site is approximately 30Ha. Taking the Tuen Mun Public Fill Bank as a reference (Figure 1), the material storage capacity should be in the range of about 4 million m^3. The area therefore more than satisfies the anticipated annual inflow and can cater for excess material that can be sorted and processed for use as recycled construction aggregate in other applications such as for concrete production and maintenance purposes.

3.3.2 SMB1 and SMB3

Material flow analyses were also carried out for SMB1 and SMB3 in the strategically located material banks scenario with two banks established in the Study Area. The material flows are presented for each of the banks in Figures 25 and 26.

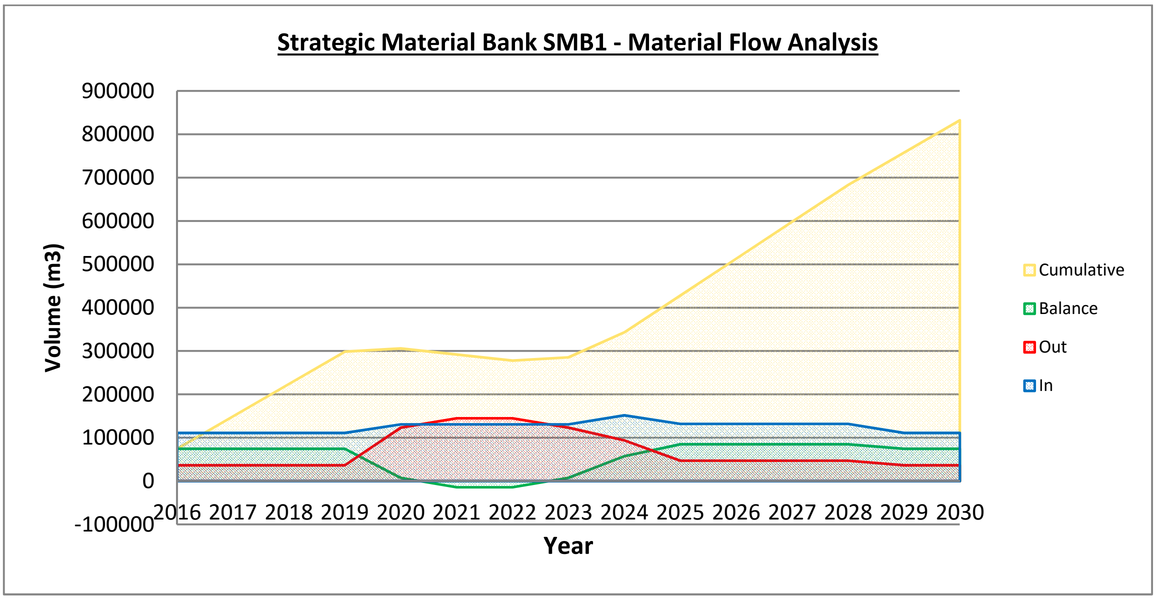


Figure 25: Estimated Material Flows into and out from SMB1 from 2016 to 2030 (SMB1 and SMB3)

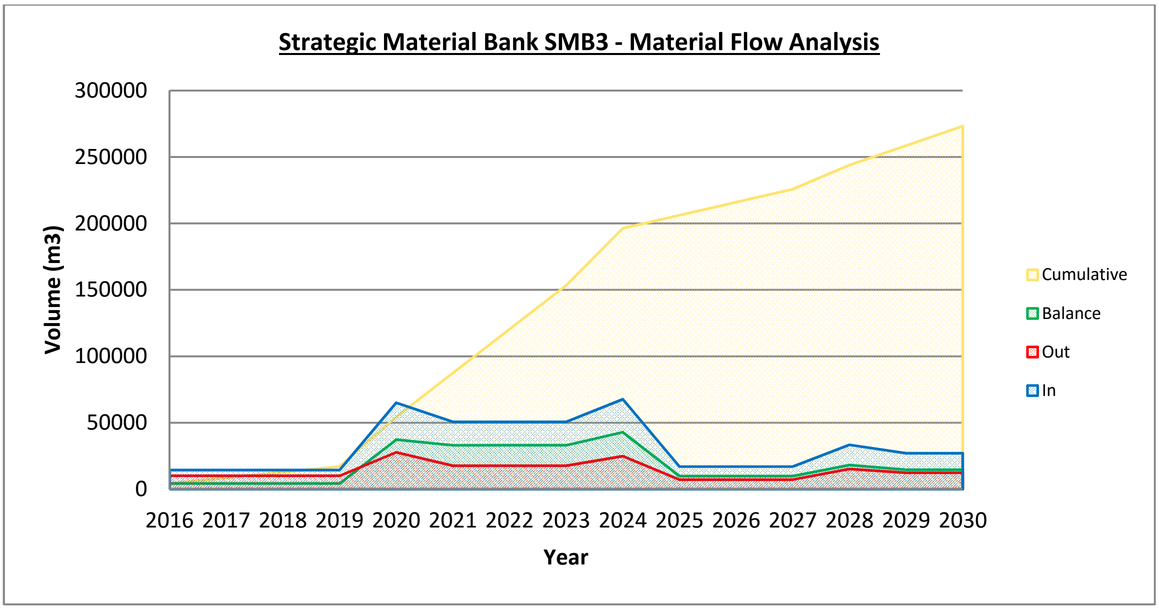


Figure 26: Estimated Material Flows into and out from SMB3 from 2016 to 2030 (SMB1 and SMB3)

From the material flow analyses it becomes evident that the volume of material handled by SMB1 is significantly more than SMB3 with a net in-flow of approximately 17 times more from 2016 to 2019 and a total cumulative flow of approximately 3 times more throughout the study time horizon. Additionally, SMB3 experiences a shortfall of recycled aggregates to satisfy projected demands until the middle of 2017 which would likely result in construction aggregates having to be located from a source further away, thus reducing the total potential environmental benefit from reduced material haulages. Tabulated annual flows into and out from SMB1 and SMB3 from their paired development areas are attached in Appendix 8.

3.4 GHG Emissions Calculation Output

GHG emissions for the business-as-usual and strategic material banks scenarios (SMB1 only, SMB1 and SMB3) have been calculated and the results are summarised in Table 10.

Table 10: Vehicle-Kilometres and GHG Emissions for Business-As-Usual and Strategic Material Bank Scenarios.

Scenario	Material Flows Into Development Areas From Material Banks (Recycled Aggregate)		Material Flows Out From Development Areas To Material Banks (Granular Arisings)		Total Flows (In and Out of Development Areas)	
	Haulage Distance ('000s vkm)	GHG Emissions (T CO_2e)	Haulage Distance ('000s vkm)	GHG Emissions (T CO_2e)	Haulage Distance ('000s vkm)	GHG Emissions (T CO_2e)
Business-As-Usual	3505	3323	8735	8281	12240	11604
Strategic Material Bank SMB1	1638	1553	5066	4803	6704	6356
Reduction from Business-As-Usual	1867	**1770**	3669	**3478**	5536	**5248**
% Reduction	**53%**		**42%**		**45%**	
Strategic Material Banks SMB1 and SMB3	1450	1553	4621	4803	6071	6356
Reduction From Business-As-Usual	2055	**1948**	4114	**3900**	6169	**5848**
% Reduction	**59%**		**47%**		**50%**	

The calculations of the GHG emissions for the above scenarios are provided in Appendix 9. The results presented in Table 10 are further elaborated in the Analysis and Discussion section.

3.5 Strategically Located Banks versus Business-As-Usual

Strategically locating material banks with a regional perspective on material flows for the selected Study Area and within the time horizon of the study has identified significant potential reductions in GHG emissions. These potential reductions in GHG emissions are a result of reduced vehicle-kilometres travelled by HGVs hauling construction materials. The construction materials and their flows considered within the boundary of this analysis are excess granular arisings transported from development areas to material banks and recycled aggregate transported from material banks to development areas.

Based on the reduced material haulage distances from strategically locating one material bank (SMB1) for the purposes of receiving, processing and redistributing net granular arisings from nearby development projects, a reduction of 42% of GHG emissions associated with the transportation of these material outflows from development areas has been estimated. These granular arisings comprising rock and natural sands and gravels are materials that are commonly recognised in the construction industry as having intrinsic value in the form of recyclable aggregates (Magnusson et al., 2015, SGU, 2015) and as such, would normally be either sorted, processed and reused on site or transported to a material bank for processing and redistributing at a later date as recycled aggregate. Therefore, this reduction of 42% of GHG emissions from transportation of net granular arisings represents a minimum potential reduction for the Study Area. Estimated quantities of net granular arisings from the ESAR model together with quantities from Cross-Connection Södertörn project reduction of approximately 3.67 million vehicle-kilometres equating to an estimated saving of 3478 tonnes of CO_2e that can be achieved from the transportation of these materials throughout the study's time horizon.

Excavated and recycled aggregates in the form of processed crushed rock and natural sands and gravels from construction sites are identical to quarried and processed primary aggregates. Aggregate demands for sub-surface backfilling aggregates and road construction can be theoretically satisfied by recycled aggregates and an increased use of recycled aggregates from CDW is a strategic goal of Sweden's EPA (Swedish EPA, 2012). With this premise, a reduction of 53% of GHG emissions can be achieved from strategically locating one material bank within the Study Area, assuming that the material bank is able to satisfy the construction aggregate demand for sub-surface building development earthworks and the Cross-Connection Södertörn. Based on the estimated construction aggregate demand from the ESAR model and from the earthworks quantities estimated for Cross-Connection Södertörn, the potential reduction in haulage distance is approximately 1.87 million vehicle-kilometres equating to a saving of 1770 tonnes of CO_2e within the Study Area. This brings the total potential reduction in GHG emissions from material transportation related to the construction activities within the analysis boundary to 45% (5.55 million vehicle-kilometres equating to 5248 tonnes of CO_2e based on the estimated material quantities).

The material flow analysis conducted for strategically located material bank SMB1 (section 3.3.1) indicates that received granular arisings from the development sites throughout the time horizon of the study is sufficient to meet the construction aggregate demands from construction activities within the boundary of this study. Therefore, the potential savings in GHG emissions from construction aggregate transportation to development areas is achievable - subject to a sound regional materials management approach.

A deeper investigation into the potential benefits of strategically locating more than one material bank within the Study Area was carried out with two material banks; SMB1 and SMB3, considered within the strategically located material banks scenario. For this particular Study Area, the environmental benefit of establishing more than one material bank is considered to be nominal, with an additional 5% reduction in GHG emissions from the transportation of materials. This is primarily due to the comparatively lower material flows into SMB3, with SMB1 centrally located to developments with the largest anticipated material flows. Nevertheless, the deeper investigation has offered further support towards the need to obtain relatively accurate estimations of material flow quantities and qualities at the regional planning level in order to facilitate strategic regional materials management through the establishment of strategic material banks.

3.5.1 A Surplus of Recycled Aggregates

Based on estimated material flows, there is a projected accumulation of materials within SMB1 (Figure 24). The projected surplus recycled aggregates could be used in the production of concrete and for other purposes such as road maintenance and in turn, reduce the consumption of primary aggregates. Extraction and production of these primary aggregates from quarries and their imports can thus be avoided offering additional environmental benefits (Blengini and Garbarino, 2010).

The assumption of using 100% recycled aggregates for the backfilling works and Cross-Connection Södertörn road construction can arguably be a conservative assumption when making the comparison between established strategic material banks and business-as-usual. Directing CDW materials to strategic material banks and importing recycled aggregates from these banks can be enforced within construction contract documents, raising the project level materials management to the regional level. Under the business-as-usual scenario with material management handled by Contractors, backfilling materials for construction activities within the analysis boundary may not necessarily come from recycled aggregates. Similarly, transportation of CDW to material banks may not necessarily be the Contractor's preferred choice and this material may ultimately end up within a landfill.

3.6 Factors Influencing the Results

The reduction in GHG emissions between the two scenarios of this study; business-as-usual and strategically located material banks, is directly related to reductions in transportation distances achieved from strategically locating material banks closer to development areas. However, the estimated quantities of GHG emissions saved are subject to several factors within the Study Area and assumptions made during the methodology. Certain factors and assumptions have been identified as having a significant impact on the quantities of estimated GHG emissions. These will be discussed in the following sub-sections.

3.6.1 Geology

The geology encountered within the development areas has potentially the largest impact on the results with quantities of granular arisings dependent on geological conditions at each site. With the detailed locations of construction activities within development areas largely unknown at the regional planning level, the geology at each development site has been simplified by using percentages of rock and soil types encountered over the entire development area. With this methodology, this particular Study Area has yielded larger quantities of granular arisings than estimated aggregate demand for most of the development areas. The environmental and economical feasibility of establishing strategic material banks therefore relies heavily upon the geology of a region.

3.6.2 Rock Quality

Excavated rock has been categorised as being a granular arising with 100% reusability as recycled aggregate in this study (section 2.1.1.3.6). This effectively does not account for various degrees of weathering that may be encountered or any excavated rocks that may be classified as unsuitable for use as a construction aggregate. Such an assumption may have an impact on strategically locating a material bank with preference to locate the banks closer to areas with higher potential for generating recyclable CDW.

3.6.3 HGV Laden Values

HGVs used to transport aggregates are assumed to have a maximum load of 14 tonnes with a transportation loop of maximum load out and empty on return. The load capacity and transportation loop are directly proportional to vehicle-kilometres travelled. Having the same transportation assumptions under both scenarios yields a percentage reduction in GHG emissions that holds true regardless of these assumptions. However, the quantity of GHG savings can be significantly affected by these transportation assumptions. Needless to say, larger maximum transportation loads and a more efficient materials transportation management would result in significant GHG reductions under both scenarios.

3.6.4 Assumptions and Parameters of the ESAR Model

The material quantities flowing into and out from development areas plotted on Figure 14, clearly shows an overall surplus of material flowing out from the majority of development projects. Whilst geology plays a crucial role in the proportion of granular arisings, another main reason for the overall surplus is related to ESAR model assumptions and input parameters. Firstly, the model has been developed based on an existing residential area (the Annedal residential area) comprising multi-family dwellings (apartments) with basement structures (typically underground parking in more dense urban areas). With little known about the detailed layout and facilities of future multi-storey residential developments, the model's recommended standard values based on the Annedal residential area have been used for all apartment constructions. Similarly, quantities of excavated materials for low-rise commercial developments are based on the gross floor area multiplied by a standard excavation depth. In reality, excavations for building foundations and underground facilities are subject to multiple variables such as geological conditions, site constraints and the developer's plans to name a few.

3.6.5 Development Timeline

Linear rates of development were assumed over the entire time horizon of the study for all development areas within two of three municipalities. This assumption was made due to limited information available within the MCPs related in relation to a development timeline and is based on the linear annual development targets set within the MCPs. As such, the material banks were strategically located with consideration towards total material flows within the time horizon and the assumed development timeline used only to perform the material flow analyses for the material banks. The material flow analyses were carried out to determine if sufficient quantities of recycled aggregate were available to meet demands throughout the banks operational timeline. This is important as any material deficit would mean that construction aggregates would need to be sourced elsewhere, eroding the total potential environmental benefit of a strategically located material bank. Similarly, any material surpluses beyond a projected demand could be identified and highlighted as recycled aggregate that may potentially be used for other construction activities in substitution of primary aggregates. The assumptions on linear rates of development resulted in favourable material flows for SMB1. However, for a sound regional materials management approach, more detailed information regarding development timelines would be required.

3.6.6 Percentage of Site Reuse

A reuse percentage for granular arisings of 15% was assumed for building developments and 50% for the Cross-Connection Södertörn within this study. This assumption was made based on a general theme of densification of urban areas within the regional and municipal development plans, whereby available area for sorting, processing and storing excavated materials onsite is more limited in dense city regions. Increasing this percentage will reduce the material flow quantities and hence GHG emission savings related to reduced material haulages. Nevertheless, Magnusson et al. (2015) highlights studies related to the extensive environmental benefits from site reuse of excavated materials, indicating that this should be a first priority within all construction projects.

3.6.7 Population Projections

Population projections are a required input of the ESAR model for obtaining estimations of granular arisings and construction aggregate demands from residential building developments. High and low population growth scenarios are presented within the MCPs and for this study, an average population projection has been taken and checked against residential development targets. With material quantities assumed to be directly proportional to population growth in the ESAR model, the input population projection will have a direct impact on estimated material flows within a study area.

4 Conclusions and Recommendations

4.1 Conclusions of the Study

The purpose of this study was: *"To investigate the potential environmental benefits in terms of reductions in CO_2e, of strategically located material banks between future development areas, detailed within long-term municipal comprehensive plans in the Södertörn area, with a focus on reducing material transportation distances"*. Based on long-term MCPs for the municipalities of Botkyrka, Huddinge and Haninge, with a time horizon up to 2030, quantities of granular arisings and construction aggregate demands were estimated using Ecoloop's ESAR model for building developments and a bespoke spreadsheet for the Cross-Connection Södertörn. Potential material banks were subsequently located and from them, one strategically located material bank was selected as the optimal material bank based on proximity to clusters of developments anticipated to have the highest material flows as well as the most reductions in total vehicle-kilometres of transporting estimated quantities of granular arisings and recycled aggregates within the study area. In comparison to the Business-as-usual scenario of utilising existing and planned material banks, the strategically located material bank within the Study Area offers a potential reduction of 42% of GHG emissions from the transportation of granular arisings from development areas to material banks and a 53% reduction from the transportation of recycled construction aggregate from material banks to development areas. Based on estimated material quantities, a total combined reduction of 45% is calculated equating to a reduction of 5248T CO2e.

A further analysis was carried out to investigate the aggregated environmental benefit of having two strategically located material banks SMB1 and SMB3 with regards to facilitating further reductions in GHG emissions from further reduced vehicle-kilometres. The additional material bank resulted in an additional 5% reduction in GHG emissions when compared to the establishment of just one material bank; SMB1. The rapidly diminished additional environmental benefit from establishing an additional material bank within the study area has resulted in the conclusion that the establishment of a single strategically located material bank, SMB1, remains an optimal solution for the Study Area and highlights the magnitude of the environmental benefit from reduced material transportation distances, of strategically locating material banks with a regional perspective.

4.2 Recommendations for Future Similar Studies

4.2.1 ESAR Model Validation

The ESAR model is a useful tool, offering a simplified method of approximating excavated material quantities and backfilling aggregate demands at a regional scale with little known detailed information. With the development of the model based on one existing residential development, further validation of the model assumptions and factors used is highly recommended. Through collaboration between Contractors, Consultants and Developers, actual earthworks quantities from existing and future developments should be attainable and offer a simple and effective way of testing and validating the ESAR model.

4.2.2 Employment Projections

The ESAR model has been constructed with key inputs that are considered to be available at a regional planning level such as projected population figures. While the key input data was generally available for residential developments (through data interpretation) as well as information on significant commercial developments, limited information in the form of useful input parameters was available for the less significant commercial developments - in particular, gross floor area. However, projected figures for new job creation were given within all MCPs. Integrating job creation figures into the ESAR model by, for example, relating job numbers to gross-floor areas may be one way of capturing material quantities arising from commercial developments outside of the main commercial development areas.

4.2.3 GIS Map Layers for Degrees of Availability

Previous work carried out by Morén (2015) resulted in the production of GIS map layers showing the degrees of availability for locating potential material banks within the Södertörn area and proved to be an extremely useful visual based method for carrying out a preliminary screening of potential sites. Morén (2015) acknowledges shortfalls in the criteria used to build the GIS map layers that are of importance for a more detailed siting of material banks. Identified shortfalls include the lack of topographical and geotechnical considerations that may impact the constructability of material banks. Such information should be further investigated when narrowing down options for material banks. This has not been done for this analysis, with the optimum bank selected on the basis of the bank having the highest environmental benefit regarding vehicle-kilometres of material haulage. Another important criterion that has not been displayed within the GIS based visual method is the land ownership and willingness of landowner's to lease or sell the land for the establishment of a material bank. This along with other shortfalls detailed within Morén's (2015) study should be further investigated during subsequent stages of locating potential material bank sites.

4.2.4 Incorporation of SGU's Rock Quality Map

SGU has a Rock Quality Map that is constantly being updated to identify areas of high quality construction aggregate assets. Incorporating such a quality map into the ESAR model would help to increase the certainty in the quantity of recyclable CDW arising from future development areas.

4.2.5 Methodological Alternatives

4.2.5.1 Identifying Development Clusters Located Furthest Away from Material Banks

The visual based method for identifying development clusters furthest away from existing material banks (section 2.2.2) may not be as obvious as within the chosen case-study area. As an alternative to the visual based method, the Service Area approach within the Transport Analysis extension in GIS software ArcMap could be utilised. The Service Area function in the Transport Analysis extension allows the user to generate polygons around facilities based on a specified travel distance. In this case, the facility would be the material bank, and a specified travel distance along the road network could be set to identify development locations further than this specified distance from existing material banks. The specified distance could be determined based on a weighted average transportation distance between existing material banks and development projects, with a distance set to less than or equal to the weighted average distance (the weighting based on estimated material flow quantities). This in turn could then be used to identify clusters of development areas that would benefit the most from a more centrally located material bank.

4.2.5.2 Obtaining Transportation Routes

The transportation routes for the transportation analysis were obtained using Google Maps Direction Tool. This proved to be a very time consuming approach and subject to higher risk of manual errors. The originally intended approach of using the Closest Facility tool within the Transport Analysis extension of ArcMap (section 2.2.3.3), whereby the closest routes between facilities (material banks) and incidents (development areas) can be identified along an imported network data set (e.g. BK1 roads), is thus recommended for any future investigations of a similar nature.

4.2.6 Collaboration with Municipalities

4.2.6.1 Standardisation of MCPs

During the data collection stage of this study, it was observed early on that the information and level of detail presented within MCPs varied significantly between municipalities (Table 4). To facilitate a regional materials management approach based on estimations of future material flow quantities and qualities that will flow within and between municipals, a standardisation of the level of detail and information presented within long-term municipal plans is crucial. While it is understood that the level of uncertainty increases with time regarding projections, information related to population projections at the district level rather than municipal level would help to facilitate more accurate estimations of the extents of construction activities at particular locations that would in turn, assist in strategically locating a material bank to handle CDW and supply recycled aggregates. Additionally, a more detailed development timeline would facilitate more accurate material flow analyses for identifying material surpluses and deficits that may arise within material banks during their operation.

4.2.6.2 Incorporation of Strategic Material Banks into MCPs

Although future development areas were included in the GIS map layers for degrees of availability (Morén, 2015), consideration should be given to the temporary use of future development sites for material banks. Establishing temporary material banks over areas designated for future development may not only centrally locate a material bank near other future development areas but may also provide an opportunity for ground improvement in the form of surcharge for areas where the underlying geology comprises soft compressible soils. Strategic material banks identified as part of the regional planning process should be integrated into long-term MCPs, as this would be the ideal way to safeguard potential sites and fast track their establishments.

5 Further Research

5.1 Additional Environmental Benefits Beyond the Problem Boundary

5.1.1 Other CDW Materials

Briefly mentioned within the Analysis and Discussion section was the possible use of surplus recycled aggregates for construction activities beyond the boundary of this study that would ultimately contribute to additional reductions in GHG emissions. In addition to this, inert demolition materials such as demolition concrete, brick, tiles and asphalt plainings are CDW materials that have not been included in the analysis boundary. These materials could be directed towards strategically established material banks and contribute to further reductions in the demand for primary aggregates.

5.1.2 LCA of Strategically Located Material Banks

While the environmental benefit in terms of reduction in CO_2e from reduced transportation distances of construction minerals has been the focus of this study, conducting a LCA for the establishment of strategic material banks can capture the overall environmental costs and benefits within an extended boundary. This extended boundary may, as an example, include the reduced demand for primary aggregates, reduced road wear and associated maintenance, increased life of distribution lorries from reduced vehicle-kilometres and reduced amount of landfill space taken up by disposal of CDW along with the impacts associated with the land-use change to establish strategic material banks and emissions related to the processing of CDW. Furthermore, approximating life-cycle GHG emissions associated with the establishment of material banks can also serve as an environmental breakeven benchmark when considering environmental time-to-pay-off for setting up additional material banks within a study area.

5.1.3 Delimitations on Construction Activities and Development Types

Low rise residential housing has been omitted from the analysis boundary. The reason for omitting low rise residential housing is that the quantities of ESAR are assumed to be insignificant due to shallow foundations (i.e. no basement structures considered). However, earthworks from the associated infrastructure such as roads leading up to the houses along with the installation of buried utilities are likely to give rise to net aggregate demands. Similarly, apart from the Cross-Connection Södertörn, infrastructure outside of the development areas such as new roads and utilities have not been included in this analysis and are also likely to increase aggregate demand. Whilst the commercial and multi-storey residential building developments included in this analysis are considered to be of most significance from an earthworks perspective, these excluded developments and associated infrastructures are likely to generate net demands on construction aggregates and including these may help to identify further GHG emission savings from the use of recycled aggregates.

5.1.4 Cohesive Soils

There is a recognized need to establish sites for dumping excavation material – the latter specified as being primarily located in the southern half of Stockholm (TRF, 2010). Wet cohesive soils (clays and silts) are typically classified as unsuitable and are commonly disposed of. Haulage distances for cohesive soils leaving construction site boundaries for disposal are typically much longer than that for granular arisings as a result of their inherently lower construction value (Magnusson, 2015). Another key focus area of the Optimass project is related to the upgrading of these wet cohesive soils. Upgrading of unsuitable materials will put less pressure on the land demand for disposal and provide another source of recycled material which can replace virgin construction minerals.

From the ESAR model and bespoke spreadsheet for the Cross-Connection Södertörn, after taking into account site reuse of cohesive soils for general backfilling purposes, approximately 5.16 million tonnes of cohesive soils are estimated to be leaving construction site boundaries within the Study Area between 2016 and 2030. Comparatively, 6.55 million tonnes of granular arisings are estimated to be transported to material banks for recycling purposes. This is approximately 44% of total excavated materials leaving the construction site boundaries excluding artificial fill, other CDWs and organic soils. Given the longer haulage distances for cohesive soils to receptor facilities coupled with the significant quantities that can be generated, establishing strategic material banks for the purpose of receiving and upgrading these materials would have substantial environmental and economical benefits.

5.2 Validation of the Study

Data collection of actual excavated material types and quantities, destination and sources of granular arisings and construction aggregate and fuel consumption associated with the transportation of these materials could be carried out for upcoming projects identified within the Study Area. This information could be used to validate the methods, models and assumptions of the study and identify areas for further refinement.

5.3 Competition Among Material Banks

There is a general consensus that there is an insufficient number of material banks located in close proximity to urban areas in the Södertörn area (Morén, 2015). Nevertheless, establishment of strategically located material banks would have an impact on material flows within a region. As highlighted in this study, strategic material banks may be new banks or existing banks that are already fairly centrally located to future development areas. When identifying and safeguarding strategic material banks, there is a need to engage all stakeholders at the outset, agreeing at the regional level the durations that key material suppliers and receivers shall remain operational. An investigation into the impacts from increased competition on neighbouring existing material banks should therefore be carried out. Material flows that are reduced to strategically important existing material banks must not reach a critical level that may result in the material bank's closure.

5.4 Consideration of Temporary Existing Material Banks

Temporary material banks have been identified within the Study Area. However, the duration that these material banks will remain operational for is limited and they are therefore assumed not to be operational under the business-as-usual and the strategically located material banks scenarios. However, as highlighted by Morén (2015), the permit process for opening new material banks is stringent and subject to numerous criterions being satisfied. Consideration should therefore be made towards strategically locating material banks at existing temporary material bank sites, extending their operational duration to receive and supply material throughout a specified development time horizon.

5.5 Optimising Material Logistics

A regional materials management approach whereby material banks are contractually designated to receive and supply CDW and recycled aggregate respectively from development projects, offers an opportunity to optimise the logistics of these materials. With a common location for depositing and collecting materials for a development project, the average laden value of HGVs can be increased dramatically. With a typical laden value of 50% assumed for this study, representing a full load out and empty return, a full load each way would effectively half the GHG emissions for those materials that would otherwise be transported separately. While this would not be achievable for all material flows all the time, there is clearly a potential for improved materials management through the identification and utilisation of strategically located material banks.

5.6 Economical Considerations

This study has a primary focus on environmental benefits of strategically locating material banks for the management of CDW materials at a regional level between development areas detailed in long-term development plans. The economic viability of establishing material banks to receive CDW and supply recycled aggregate has not been investigated in this study. Nevertheless, the economic feasibility is of paramount importance to businesses engaging in the materials management industry. The regional management of materials may introduce a new dynamic into the traditional materials management industry. By shifting the total responsibility of CDW handling away from the Contractor towards a more regionally managed approach (through the introduction of contractual requirements for the handling of CDW and utilisation of recycled aggregates), savings to the total costs of development projects may arise, provided strategically located terminals can offer lower production and transportation costs than competing construction mineral quarries. When considering the transportation costs alone, with fuel combustion being the predominant source of GHG emissions related to the transportation of materials, the economical benefit is likely to be proportional to reduced vehicle-kilometres in the form of reduced fuel purchases along with other indirectly related costs such as vehicle maintenance etc. As such, potential reductions in GHG emissions may be indicative of the magnitude of related economical savings from a transportation perspective alone. The time to pay off for other costs of establishing new material banks, operating the banks and finally, decommissioning the banks will be directly proportional to material flow quantities and qualities. This gives support for the need to identify excavated material quantities and qualities at a regional level over a projected time horizon - a main objective of Ecoloop's ESAR model.

5.7 Concluding Remarks

This study is a first complete attempt of utilising Ecoloop's ESAR model and GIS Degrees of Availability map layers, together with the development of a methodology for strategically locating material banks within three municipalities of the Södertörn area. Taking the three municipalities in Södertörn as a case-study area to evaluate environmental benefits of strategically locating material banks with a long-term regional perspective, there is a clear opportunity to significantly reduce GHG emissions related to the transportation of CDW and recycled aggregates alone. Along with potentially significant GHG emission reductions and economical savings beyond the boundary of this study, it is with hope that this study will initiate further investigation and eventual action into the establishment of strategically located material banks based on a regional perspective of future material flows.

6 References

Avén, S. (1984). *Geoteknik*. Stockholm: Liber Förlag. ISBN: 91-38-06077-9. p. 90.

Avén, S. (1985). *Väg- och vatten-byggnader*. Stockholm: Liber Förlag. ISBN: 91-38-06081-7. p. 117.

Barandica, J. M., Fernández-Sánchez, G., Berzosa, A., Delgado, J. A., Acosta, F. J. (2013). Applying life cycle thinking to reduce greenhouse gas emissions from road projects. *Journal of Cleaner Production, 57,* 79–91.

Bergstedt, E. and Linder, I. (1999). *Material flow study of sand and gravel in Sweden*. Statistics Sweden, p.6.

Blengini, G. A., Garbarino, E. (2010). Resources and waste management in Turin (Italy): the role of recycled aggregates in the sustainable supply mix. *Journal of Cleaner Production, 18,* 1021-1030.

Botkyrka Kommun. (2014). *Botkyrkas översiktsplan.* [Municipal Comprehensive Plan]. Retrieved May 20, 2015, from http://botkyrka.se/boochbygga/botkyrkapalangresikt/%C3%96versiktsplan.

CL:AIRE. (2013). Remediation of Four Sites in Northwest England – a Successfully Completed Multi-site Cluster Project. [Case Study Bulletin]. Retrieved July 15, 2015, from http://www.claire.co.uk/index.php?option=com_phocadownload&view=file&id=368:initiatives&Itemid=230.

Defra, CILT, DfT, Freight by Water, Food Storage and Distribution Federation, FTA, IGD, RHA, Rail Freight Group, AEA Technology, Booker Group PLC, DB Schenker Rail (UK) Ltd, Ford Moto Company Ltd, Norbert Dentressangle, Gazzard, N., Leonardi, J., McKinnon, A., Palmer, A., Samworth Distribution, Tesco, TNT UK Ltd. (2009). *Guidance on measuring and reporting Greenhouse Gas (GHG) emissions from freight transport operations.* [GHG Measuring and Reporting Guidance Document]. Retrieved July 20, 2015, from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/218574/ghg-freight-guide.pdf.

Egis Bceom International. (2010). *Introduction to Greenhouse Gas Emissions in Road Construction and Rehabilitation* [Research Report funded by The World Bank].

Eriksson, M. and Ahlgren, S. (2013). *LCAs of petrol and diesel. A literature review.* Report 2013:058. ISSN 1654-9406. Uppsala: Swedish University of Agricultural Sciences.

Fry, C. and Wayman, M. (2007). *Sustainable Aggregates. Reducing the Environmental Impact from Transporting Aggregates.* [Research Report]. Retrieved July 13, 2015, from http://www.sustainableaggregates.com/library/docs/mist/l0073_t1d_transport.pdf.

Gangolells, M., Casals, M., Gassó, S., Forcada, N., Roca, X. & Fuertes, A. (2009). A methodology for predicting the severity of environmental impacts related to the construction process of residential buildings. *Building and Environment, 44*, 558–571.

Geotechnical Engineering Office (GEO). (2000). *Geoguide 1. Guide To Retaining Wall Design.* Hong Kong: Government Publications Centre. Table 8, p.145

Google Maps. (2015). [Street Viewer and Directions tool]. Retrieved between May and July 2015, from: https://www.google.se/maps/.

Haninge Kommun. (2015). *Översiktsplan 2030 - med utblick mot 2050.* [Municipal Comprehensive Plan]. Retrieved May 20, 2015, from http://www.haninge.se/sv/Bygga-bo-och-miljo/Oversiktsplanering/Oversiktsplan-2030/.

Haninge Kommun. (2005). *Översiktsplan 2004.* [Municipal Comprehensive Plan]. Miljö och stadsbyggnadsförvaltningen. Stockholm: Haninge Kommun.

Huddinge Kommun. (2014). *Huddinge Kommun Översiktsplan 2030.* [Municipal Comprehensive Plan]. Retrieved May 20, 2015, from http://www.huddinge.se/bygga-bo-och-miljo/planer-och-ny-bebyggelse/oversiktsplan-2030/.

IPCC. (2013). *Summary for Policymakers*. In: *Climate Change 2013: The Physical Science Basis.* Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T. F., D. Qin, G. K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Israelsson, F. (2014). *Sustainable Mass Handling. Modelling quantities of excavated soil and rock in residential construction projects.* [Master Thesis]. Stockholm: KTH School of Industrial Engineering and Management.

Iterio AB. 2014. *Botkyrkas översiktsplan - nu till 2040. Miljökonsekvensbeskrivning.* [Environmental Impact Report]. Retrieved June 08, 2015, from: http://www.botkyrka.se/SiteCollectionDocuments/Bo%20och%20bygga/%C3%96versiktsplan/Botkyrkas%20%C3%B6versiktsplan_nu%20till%202040_Milj%C3%B6konsekvensbeskrivning.pdf.

Johnson, G. (2010). *Affordable Housing. Position Statements for Stockholm*. Office Of Regional Planning Stockholm County Council. Retrieved 02 June, 2015, from http://www.eurometrex.org/Docs/Expert_Groups/Affordable_Housing/Affordable_Housing_Position_Statement_Stockholm.pdf.

Larsson, B., Öhman, J., Tyréns AB. (2015). Tvärförbindelse Södertörn, Väg 259. Samrådsunderlag. [Trafikverket Document, Available Online]. Retrieved June 03, 2015, from: http://www.trafikverket.se/contentassets/ced9a72c8aa44f97be8c1827521461d4/samradsunderlag-tvarforbindelse-sodertorn-slutversion.pdf.

Lu, W. and Tam, V.W.Y. (2013). Construction waste management policies and their effectiveness in Hong Kong: A longitudinal review. *Renewable and Sustainable Energy Reviews, 23,* 214–223.

Mácsik, J. (2015). [Personal Communication]. Technical Director/Partner at Ecoloop AB. Stockholm.

Mácsik, J., Pousette, K., Jacobsson, A. (1998). *Miljögeoteknik. AFR-kompendium 7.* Stockholm: Naturvårdsverket (Swedish Environmental Protection Agency).

Magnusson, S. (2015). *Offentlig och privat materialförvaltning. PM Beräkningsmodell.* [Optimass Project Report]. Luleå: Luleå Tekniska Universitet.

Magnusson, S., Lundberg, K., Svedberg, B., Knutsson, S. (2015). Sustainable Management of excavated soil and rock in urban areas - A literature review. *Journal of Cleaner Production 93,* 18-25.

Mahtab, M.A., Rossler, K., Kalamaras, G.S., Grasso, P. (1997). Assessment Of Geological Overbreak For Tunnel Design And Contractual Claims. *Int. J. Rock Mech. & Min. Sci. 34:3-4*, paper No. 185.

Manual Of Contract Documents For Highway Works (MCHW). (2009a). *Series 800 Road Pavements - Unbound, Cement And Other Hydraulically Bound Mixtures. Volume 1 Specification for Highways Works.* Retrieved 12 May, 2015, from: http://www.standardsforhighways.co.uk/mchw/vol1/index.htm.

Manual Of Contract Documents For Highway Works (MCHW). (2009b). *Series 600 Earthworks. Volume 1 Specification for Highways Works.* Retrieved 12 May, 2015, from: http://www.standardsforhighways.co.uk/mchw/vol1/index.htm.

Morén, L. (2015). *Lokalisering av ytor för hantering av jord- och bergmaterial i Södertörn.* Uppsala: SLU, Department of Energy and Technology.

Mroueh, U. M., Eskola, P., Laine-Ylijoki, J. (2001). Life-cycle impacts of the use of industrial by-products in road and earth construction. *Waste Management, 21,* 271–277.

Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang. (2013). Anthropogenic and Natural Radiative Forcing. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Simion, I. M., Fortuna, M. E., Bonoli, A., Gavrilescu, M. (2013). Comparing environmental impacts of natural inert and recycled construction and demolition waste processing using LCA. *Journal of Environmental Engineering and Landscape Management, 21:4*, 273-287

Statens Vegvesen. (2004). *Road Tunnels Standard*. Manual 021. ISBN 82-7207-540-7. Retrieved May 12, 2015, from: http://www.vegvesen.no/_attachment/61416/binary/14123?fast_title=Manual+021E++Road+Tunnels.pdf.

Statistica Centralbyrån (Statistics Sweden, SCB). (2015). *Folkmängd i riket, län och kommuner 31 mars 2015 och befolkningsförändringar 1 januari–31 mars 2015.* Retrieved May 20, 2015, from: http://www.scb.se/sv_/Hitta-statistik/Statistik-efter-amne/Befolkning/Befolkningens-sammansattning/Befolkningsstatistik/25788/25795/Kvartals--och-halvarsstatistik---Kommun-lan-och-riket/385459/

Sveriges Geologiska Undersökning, SGU. (2015). *Industrial Minerals* and *Urban Planning*. Retrieved July 13, 2015, from http://www.sgu.se/

Swedish Environmental Protection Agency (Swedish EPA). (2012). From Waste Management to Resource Efficiency. Sweden's Waste Plan 2012 – 2017. Report 6560. Stockholm: Swedish Environmental Protection Agency.

The Engineering Toolbox. (2015). *Soil and Rock Bulking Factors.* Retrieved June 02, 2015, from: http://www.engineeringtoolbox.com/soil-rock-bulking-factor-d_1557.html

The European Commission. (2014a). *EU Transport in Figures – Statistical Pocketbook 2014.* Luxemburg: Publications Office of the European Union, 2014.

The European Commission. (2014b). *EU Energy in Figures – Statistical Pocketbook 2014*. Luxemburg: Publications Office of the European Union, 2014.

Trafikverket. (2015a). *Background – Cross Connection Södertörn.* [Posted online]. Retrieved July 22, 2015, from: http://www.trafikverket.se/Privat/Projekt/Stockholm/Tvarforbindelse-Sodertorn/Bakgrund/

Trafikverket. (2015b). *Archives - Masmölanken.* [Archived documents and drawings for Masmölanken]. Retrieved May 08, 2015, from: http://www.trafikverket.se/Privat/Projekt/Stockholm/Vag-259-Sodertornsleden/Arkiv-vag-259-Sodertornsleden/Dokument-for-vag-259-Sodertornsleden/Masmolanken/.

Trafikverket. (2015c). *Archives - Botkyrkaleden/Haningeleden 1.* [Archived documents and drawings for Botkyrkaleden and Haningeleden 1]. Retrieved May 08, 2015, from: http://www.trafikverket.se/Privat/Projekt/Stockholm/Vag-259-Sodertornsleden/Arkiv-vag-259-Sodertornsleden/Dokument-for-vag-259-Sodertornsleden/BotkyrkaledenHaningeleden-1/.

Trafikverket. (2015d). *Archives - Haningeleden 2-4.* [Archived documents and drawings for Haningeleden 2-4]. Retrieved May 13, 2015, from: http://www.trafikverket.se/Privat/Projekt/Stockholm/Vag-259-Sodertornsleden/Arkiv-vag-259-Sodertornsleden/Dokument-for-vag-259-Sodertornsleden/Haningeleden-2-4/.

Trafikverket. (2012). *Krav För Vägars och Gators Utformning*. Dokumentbeteckning: 2012:179 [VGU Version 1, Superseded with VGU Version 2 released 26 June, 2015]. Retrieved May 08, 2015, from: http://online4.ineko.se/trafikverket/Product/Category/12444.

TRF. (2010). *Regional utvecklingsplan för Stockholmsregionen,* Stockholm: Tillväxt - och regionplaneförvaltningen, TRF.

TRF. (2014). *Befolkningsprognos 2014 - 2045,* Stockholm: Tillväxt - och regionplaneförvaltningen, TRF.

UOA. (2005). *Geology Rocks and Minerals.* [Typical rock descriptions and applications]. Retrieved August 20, 2015, from: http://flexiblelearning.auckland.ac.nz/rocks_minerals/rocks/index.html.

Zuo, C., Birkin, M., Clarke, G., McEvoy, F., Bloodworth, A. (2013). Modelling the transportation of primary aggregates in England and Wales: Exploring initiatives to reduce CO2 emissions. *Land Use Policy, 34,* 112–124.

Appendix 1: Projected Populations and Timeline

a) Botkyrka

Botkyrka Residential

Summary of Information Available

Population projection for overall municipal and for grouped districts up to 2040
Actual population of grouped districts in 2012
Development Target (Number of Homes per year)
Population of Municipal as of Q1 2015
Approximate Timeline for development areas

Step 1 - Extract General Overall Population Projections for Municipality and Grouped Districts from Municipal Comprehensive Plan

To estimate current population per grouped district, the 2012 figures are scaled up. This is done by multiplying the grouped district's % share of the municipal's total population by the total population increase from 2012 to Q1 2015 and adding that value to the 2012 population figures
The population increase by 2030 for each grouped district is calculated on a pro rata basis.

Overall Population Projection

Population Q1 2015	89142	(SCB Statistics, Q1 2015)
2040 Projected Population (High)	137500	(OP 2014)
2040 Projected Population (Low)	116500	(OP 2014)
Projected population increase by 2030 (High)	29014,8	Pro-rata assuming linear increase
Projected population increase by 2030 (Low)	16414,8	Pro-rata assuming linear increase

Overall Population Projection for Districts

							Total Population Pro-rata to 2030		Increase Pro-rata to 2030	
		2040 Low	2040 High	Actual 2012	% of 2012	Pro-rata to Q1 2015	Low	High	Low	High
1	Norsborg, Hallunda, Fittja, Alby, Eriksberg	54900	62500	40900	47%	42247	49839	54399	7592	12152
2	Tumba, Vårsta	34900	42000	26250	30%	27114	31786	36046	4671	8931
3	Tullinge	24000	30000	17350	20%	17921	21569	25169	3647	7247
4	Grödinge	2500	3000	1800	2%	1859	2244	2544	384	684
Total		116300	137500	86300			105437	118157	16295	29015

Step 2 - Split Overall Population Projection into Those Living in Apartments (Multi-Family) and Those Living in Houses (Single Family) in each grouped district

Where the split of housing/apartments is not given in the Municipal Plan, the Stockholm statistics are used for average number of people living in apartments and houses.

Projection of Population Converted to Residential Units (Grouped Districts)

		From Step 1							
		Increase Pro-rata to 2030		Pop in Houses (Low Rise)		Pop in Apt (High Rise)			
Group	Location	Low	High	Low	High	Low	High	Avg	Notes
1	Norsborg, Hallunda, Fittja, Alby, Eriksberg	7592	12152	2050	3281	5542	8871	7206	Stockholm Statistics (Johnson 2010)
2	Tumba, Vårsta	4671	8931	1261	2411	3410	6520	4965	Stockholm Statistics (Johnson 2010)
3	Tullinge	3647	7247	985	1957	2662	5290	3976	Stockholm Statistics (Johnson 2010)
4	Grödinge	384	684	384	684				Assume all in low rise houses (Municipal Plan and Description)
Total		16295	29015						

Step 3 - Check population figures with development target

This is done to check the assumption of using the Stockholm statistics for split between apartments and houses

Check with Development Target

Annually	650	Residential units
Total	9750	By 2030
Of which are Apts	7117,5	Based on Statistics (Johnson, 2010)

Pop in Apt (High Rise)			Apts (based on statistics)		
Low	High	Avg	Low	High	Avg
5542	8871	7206	3260	5218	4239
3410	6520	4965	2006	3835	2921
2662	5290	3976	1566	3112	2339
			6832	12165	9499

Total Population		Equivalent Residential Units		
Low	High	Low	High	Avg
16295	29015	7759	13817	10788

Development Target is within Low and High Scenario for Apartments based on Population Figures

Step 4 - Interpretate Any Development Timeline for Each District

Timeline Considerations/Assumptions

There is a priority order timeline within the Botkyrka OP. Projects that are considered must fall within the timeline of 2015 to 2030. The order is as follows

Location	Group	Type	Start	OP Map Number
Riksten Företagspark	3	Mix	2016	24
Fittja	1	Res&MSC	2016	4
Alby	1	Mix	2016	8
Tumba C	2	Res&MSC	2016	14
Slagsta Strand	1	Res&Mix	2020	1, 2
Eriksberg	1	Mix	2020	7, 9
Storvreten	2	Res&Mix	2020	15
Between Hallunda/Fittja	1	Res&Mix	2020	3
Tullinge C	3	Res&Mix	2024	
Hallunda	1	Res&MSC	2024	6
Stråket Kring E4/E20	2	Res/Mix	2024	10, 11
Norra Kassmyra Grustag	2	Mix	2028	17
Dalvägen	2	Mix	2028	16

KEY	
Res	Residential
MSC	Predominantly Multi-Storey Commercial Buildings
Mix	Mix of multi-storey commercial with low-rise (1-2 storey) commercial buildings
LRC	Low Rise Commercial Buildings

Step 5 - Allocate % of Population Increase in Each District

Population projection for groups are assumed to be split equally for districts within the group for the purpose of illustrating the ESAR timeline.

Where the numer of storeys are not given in the OP, the number has been assumed based on surrounding buildings (using Google Maps Street Viewer). This is in line with a common statement in the OP which says that the appearance of the area should not be adversely impacted and the existing theme should be maintained.

Projection of Population Converted to Residential Units (Individual Districts, for Timeline)

Location	Group	Type	Start	Finish (est)	OP Map Number	Pop in Apt (High Rise)			Avg. No. Of Floors
						Low	High	Avg	
Fittja	1	Res&MSC	2016	2020	4	1108	1774	1442	5
Slagsta Strand	1	Res&Mix	2020	2024	1	1108	1774	1442	4
Between Hallunda/Fittja	1	Res&Mix	2020	2024	3	1108	1774	1442	5
Eriksberg (A)	1	Res&Mix	2020	2024	7	1108	1774	1442	4
Hallunda	1	Res&MSC	2024	2028	6	1108	1774	1442	7
Tumba C	2	Res&MSC	2016	2020	14	1137	2173	1655	5
Storvreten	2	Res&Mix	2020	2024	15	1137	2173	1655	7
Stråket Kring E4/E20 (A)	2	Res/Mix	2024	2032	10	1137	2173	1655	5
Tullinge C (B)	3	Res&Mix	2024	2028	21	2662	5290	3977	6

b) Haninge

Haninge Residential

Summary of Information Available

Population projection for overall municipal
Development Target (Number of Homes per year)
Population of Municipal as of Q1 2015
Projected population increase for each district to 2025 from 2005 OP. No High/Low Scenario
Typical split of multi-family (apartments) and single-family (houses)

Step 1 - Extract General Overall Population Projections from Municipal Comprehensive Plan

Overall Population Projection		
Population Q1 2015	82676	(SCB Statistics, Q1 2015)
2030 Projected Population (High)	105000	(OP 2011 update)
2030 Projected Population (Low)	88000	(RUFS 2010)
Projected population increase by 2030 (High)	22324	
Projected population increase by 2030 (Low)	5324	

Step 2 - Verification of the use of data from OP 2005

The projected population increase for each district is originally estimated from the 2005 Municipal Plan which provides projections up until 2025.
The projected population is increased on a pro rata basis to 2030 (except in the case of Handen which appears to plateau by 2025 (possibly due to densification limit).
The % of total population increase is obtained for each district (highlighted red).
The number and type of homes constructed is based on Municipal Plan descriptions where available and on Stockholm Statistics where not available.
The total number of homes is checked against the figures in the latest Municipal Plan 2014.

Allocation of Apartment Developments Based on OP Maps and Descriptions and 2005 Population Projections (Districts)

	Projected Population Increase based on 2005 OP (2015-2025)	Projected Population Increase Pro-Rata to 2030	Projected Population Increase (OP2014)	% of Total	No of Homes: Total	No of Homes: Houses	No of Homes: Apartments	No. Of Floors	Notes
Vega			10000	45%	3000	810	2190	5	Population Projection and No. Of Apartments Given in OP2014. Information on commercial GFA not given
Handen	1200	1200		5%	706	0	706	4	No. Of Homes Estimated from Population. Assume 100% Apt (Densification). Population plateaus (OP2005)
Jordbro	600	900		4%	480	0	480	5	No. Of Apartments given. 100% Apartment Development
Västerhaninge	2700	4050		18%	1929	0	0	0	Since 2001, Majority of 2000 homes commenced (OP VH 2012)
Tungelsta	1300	1950		9%	900	720	180	3	Majority of 900 Homes Low rise (75/25) (OP2015, Tungelsta OP 2012)
Vendelsö-Gudö	500	750		3%	357	246	111	4	Housing Split from 2005 OP is 550 Houses/250 Apt (69/31). Apt. Most likely near Haga
Vendelsömalm	100	150		1%	88	0	88	4	100% Apt (OP 2005) Largely commenced
Norrby	1800	2700		12%	900	900	0	0	Majority in Family Houses (Low Rise, OP2005)
Brandbergen	300	450		2%	265	0	265	5	100% Apt (OP2005)
Krigslida	0	0		0%	0	0	0	0	Limited Information on construction of Apartments. Assume Negligible
Other Coastal Areas	0	0		0%	0	0	0	0	Limited Information on construction of Apartments. Assume Negligible
		12150	10000	100%	8 625	2 676	4020		
			22 150				5427	(Including Västerhaninge)	

Check Development Target

Annually	600	Residential units
Total	9000	By 2030
Of which are Apts	6570	Based on Statistics (Johnson, 2010)

CHECK

Number of Apartments based on Population Projection is on the low side of the overall Development Projection.

This can be explained with a higher proportion of single family homes than the Stockholm average and that data for Västerhaninge has not been included as the majority of housing projects have commenced

Step 3 - Allocate % of Population Increase in Each District

This step is done to obtain a high/low/average population increase scenario based on the latest population projection figures

The % population increase obtained from Step 2 is used with the latest projected population figures

The number and type of homes constructed (Split of Housing/Apartments) is based on Municipal Plan descriptions where available and on Stockholm Statistics where not available.

Where the numer of storeys are not given in the OP, the number has been assumed based on surrounding buildings (using Google Maps Street Viewer). This is in line with a common statement in the OP which says that the appearance of the area should not be adversely impacted and the existing theme should be maintained.

Projection of Population Converted to Residential Units (Districts)

		Increase of Total Population Projection for Districts		Pop in Houses (Low Rise)		Pop in Apt (High Rise)			Avg. No.	
	% of Total	Low	High	Low	High	Low	High	Avg	Of Floors	Split of Housing/Apartments
Vega	45%	2404	10079	649	2721	1755	7357	4556	5	(27/73)
Handen	5%	288	1209	0	0	288	1209	749	4	(0/100)
Jordbro	4%	216	907	0	0	216	907	562	5	0/100)
Västerhaninge	18%	973	4082	973	4082	0	0	0	0	(100/0)
Tungelsta	9%	469	1965	352	1474	117	491	305	3	(75/25)
Vendelsö-Gudö	3%	180	756	124	522	56	234	146	4	(69/31)
Vendelsömalm	1%	36	151	0	0	36	151	94	4	(0/100)
Norrby	12%	649	2721	649	2721	0	0	0	0	(100/0)
Brandbergen	2%	108	454	0	0	108	454	281	5	(0/100)
Krigslida	0%	0	0	0	0	0	0	0	0	(100/0)
Other Coastal Areas	0%	0	0	0	0	0	0	0	0	(100/0)
		5324	22324							

Timeline Consideration

Step 1 - Timeline Consideration

Timeline Considerations/Assumptions

Due to a lack of available information, a linear increase shall be assumed. This is inline with annual target increases in the number of homes constructed detailed in the Municipal Plans

Other Notes and Assumptions

The projected population to 2025 is given in OP 2005 for each district. This is pro-rata'd to 2030 (with the exception of Handen which seems to plateau by 2023). This is then used to allocate a percentage of the overall projected population increase for Haninge in the 2014 OP to each district to obtain a high/low scenario for population growth. From the comparison of figures, the OP 2005 population growth is very similar to the 2014 OP projection.

Split of Housing/Apartments is given in 2005 OP as a description. This is used to determine the population in apartments.

As a check, the number of homes based on the population figures in the 2005 OP is combined with information available from the 2014 OP to see if the housing development projection matches the population figures

The overall housing development is comparable but the apartment figures are somewhat lower. This is explained above (Purple text)

Where the numer of storeys are not given in the OP, the number has been assumed based on surrounding buildings. This is in line with a common statement in the OP which says that the appearance of the area should not be adversely impacted and the existing theme should be maintained.

Where the location of Apts and Low rise housing is not given, this is assumed based on surrounding buildings.

c) Huddinge

Huddinge Residential

Summary of Information Available

Population projection for overall municipal
Development Target (Number of Homes per year)
Population and number of homes in each district in 2011
Population of Municipal as of Q1 2015

Step 1 - Extract General Overall Population Projections from Municipal Comprehensive Plan

Overall Population Projection

Population Q1 2015	104353	(SCB Statistics, Q1 2015)
2030 Projected Population (High)	150000	(OP 2014)
2030 Projected Population (Low)	122000	(OP 2014)
Projected population increase by 2030 (High)	45647	
Projected population increase by 2030 (Low)	17647	

Step 2 - Split Overall Population Projection into Those Living in Apartments (Multi-Family) and Those Living in Houses (Single Family)

Projection of Population Converted to Residential Units (Overall)

	Low	High	Average	
Assumed Population living in Houses	4765	12325	8545	(Johnson 2010)
Assumed Population living in Apartments	12882	33322	23102	(Johnson 2010)
Total No. Of Residential Units (Est. From Statistics)	9166	23710	16438	(Johnson 2010)

Step 3 - Allocate % of Population Increase in Each District

This is done by allocating a share of total number of homes to each district based on the Municipal Development Maps and Descriptions.
For Districts that detail the number of apartments, the allocation of the total number of apartments is straight forward.
For the other Districts that do not detail the number of apartments, the allocation % is obtained from descriptions (such as mainly apartments/single family homes etc.) and approximate % of areas for development given on the District development maps.
The allocated % is checked against the existing population and number of homes in each district to check that the ranking order of home allocations are appropriate
The allocated % of homes is then applied to the overall municipal population increase scenarios to obtain a population increase for each district
Where the numer of storeys are not given in the OP, the number has been assumed based on surrounding buildings (using Google Maps Street Viewer).
This is in line with a common statement in the OP which says that the appearance of the area should not be adversely impacted and the existing theme should be maintained.
The equivalent population from the number of apartments is obtained by multiplying the number of apartments by the average number of people living in apartments in Stockholm from the Stockholm statistics and is checked against the population projection range in Step 2.

Development Target

Annually	700	Residential units
Total	10500	By 2030
Of which are Apts	7665	(Based on Statistics)

Allocation of Apartment Developments Based on OP Maps and Descriptions

	No. Of Apartments Based on OP, Plans and			% of Total	Equivalent	Population based on % Projection			No. Of	
	Low	High	Average	Average	Population	Low	High	Average	Floors	Notes
Storängen	2300	3200	2750	36%	4 675	4622	11955	8289	5	No. Of Apartments given
Huddinge Centrum	2000	2000	2000	26%	3 400	3361	8695	6028	5	No. Of Apartments given
Skogås	900	900	900	12%	1 530	1513	3913	2713	5	
Trångsund	900	900	900	12%	1 530	1513	3913	2713	6	
Vårby Gård	500	500	500	7%	850	840	2174	1507	5	
Stuvsta	250	250	250	3%	425	420	1087	754	3	
Segeltorp	200	200	200	3%	340	336	869	603	4	
Masmo Vårby Haga	150	150	150	2%	255	252	652	453	5	
	7 200	8 100	7 650	100%	13 005	12 857	33 257	23 060		

Check of existing ranking of Population and Homes (2011)

	Populatio	Homes	Ranking
Storängen			
Huddinge Centrum	14585	6863	1
Skogås	12895	5109	2
Trångsund	8453	4071	3
Vårby Gård	7954	3090	4
Stuvsta	8173	2944	5
Segeltorp	6504	2193	6
Masmo Vårby Haga	2655	1272	7

Other Areas

	Population	In Houses	In Apartments		Equivalent Population				No. Of Floors	Notes
Flemingsberg	13400	3618	9782		9 782				4	Population and Apartments given. Assume 27/73 Split
	Apt Low	Apt High	Apt Avg							
Loviseberg och Glömstadalen	3000	3500	3250		5 525	Additional Development Area. Dependant on Cross-Södertorn Connection. Possibly out of time horizon (>2030)				
				Total	28 312	Check against figure in Step 2				

Notes and Assumptions

Equivalent Population living in Projected Number of Apartments is within the low and high limits of population living in apartments based on the overall Projected Population. Towards the high end possibly due to only one population scenario for Flemingsberg (possibly high population scenario)
To obtain a Low/High/Average Scenario for Residential, the projected population has been split up for the different districts based on the allocation % of Apartments from Description and OP Maps

Timeline Consideration

Step 1 - Timeline Consideration

Timeline Considerations/Assumptions

Due to a lack of available information, a linear increase shall be assumed. This is inline with annual target increases in the number of homes constructed detailed in the Municipal Plans

	Start	Finish	Notes/Comments in OP
Storängen	2016	2030	To be constructed over a long period detailed in the OP. Assume linear development
Huddinge Centrum	2016	2030	No details. Assume linear
Skogås	2016	2030	No details. Assume linear
Trångsund	2016	2030	No details. Assume linear
Vårby Gård	2016	2030	No details. Assume linear
Stuvsta	2016	2030	No details. Assume linear
Segeltorp	2016	2030	No details. Assume linear
Masmo Vårby Haga	2016	2030	No details. Assume linear
Loviseberg och Glömstadalen	Unknown	Uknown	Hypothetical development area. Nothing specifically zoned yet. Possibly out of time scope.

Appendix 2: Commercial GFA

a) Botkyrka

Botkyrka Commercial

Summary of Information Available

Commercial Gross Area obtained from 2002 MKB. Statement in 2014 OP that plans are predominantly similar except with more densification detailed
Gross Floor Area (GFA) of commercial development areas is grouped into three locations

Step 1 - Summarise available information and pro rata to 2030

Overall Projection (OP MKB 2002) up to 2040

Location	Area (m^2)	Pro-rata from 2015 to 2030	Group
Norra Botkyrka	100000	40000	1
Tumba & Vårsta	600000	237000	2
Tullinge-Riksten	300000	119000	3

Step 2 - Allocate Commercial GFA to each district/development area

Where actual GFA is not given in the Municipal Plan, the allocation amount is based on descriptions and maps.
A percentage of GFA for Multi-storey developments is estimated based on the development maps and surroundings. For example, develpment in a central location is assumed to have 100% MSC. Locations outside the central areas will vary depending on description and surrounding buildings (using Google Maps).

Allocation of Area Based on OP Maps and Descriptions

Location	Group	Type	Start	Finish (est)	OP Map Number	%MSC	Commercial GFA (2002 MKB)	GFA for MSC	Number of Floors (For MSC)	GFA for LRC	Notes
Riksten Företagspark	3	Mix	2016	2020	24	25%	35000	8750	3	26250	Approx. 30000 GFA for entire business park.
Fittja	1	Res&MSC	2016	2020	4	100%	6000	6000	5	0	MSC only
Alby	1	Mix	2016	2020	8	50%	8000	4000	3	4000	
Tumba C	2	Res&MSC	2016	2020	14	100%	16000	16000	4	0	MSC only
Slagsta Strand	1	Res&Mix	2020	2024	1	50%	6000	3000	4	3000	
Eriksberg (A)	1	Mix	2020	2024	7	75%	4000	3000	4	1000	
Eriksberg (B)	1	Mix	2020	2024	9	75%	4000	3000	3	1000	
Storvreten	2	Res&Mix	2020	2024	15	75%	48000	36000	5	12000	
Between Hallunda/Fittja	1	Res&Mix	2020	2024	3	75%	8000	6000	5	2000	
Tullinge C (A)	3	Mix	2024	2028	20	75%	50000	37500	3	12500	Area Included In Flemingsberg
Tullinge C (B)	3	Res&Mix	2024	2028	21	75%	34000	25500	5	8500	
Hallunda	1	Res&MSC	2024	2028	6	100%	4000	4000	7	0	MSC only. Quite Built up already, soils estimation may be better for isolated areas
Stråket Kring E4/E20 (A)	2	Res/Mix	2024	2032	10	75%	40000	30000	4	10000	Res portion mainly in Hagelby.
Stråket Kring E4/E20 (B)	2	Res/Mix	2024	2032	11	75%	40000	30000	4	10000	Res portion mainly in Hagelby.
Norra Kassmyra Grustag	2	Mix	2028	2032	17	25%	48000	12000	3	36000	
Dalvägen	2	Mix	2028	2032	16	25%	48000	12000	3	36000	

Check Group Total	
1	40000
2	240000
3	119000

Other Notes and Assumptions

The OP has a time horizon up to 2040. As the time horizon in consideration is up to 2030 in line with RUFS and other OPs (Huddinge and Haninge) the figures have been pro-rata assuming linear increases.

Shops/Trade may be located on G/F of Residential Buildings (particularly in the city centre). However this may not result in double counting because if G/F area is used for commercial, the residential area demand is still there (based on population/no. Of flats) and therefore, additional development would still be needed.

b) Haninge

Haninge Commercial

Summary of Information Available

Gross Floor Area (GFA) of significant commercial development areas
Commercial GFA for Jordbro

Step 1 - Summarise Available Information from Municipal Plans

Major Areas OP 2014

Location	Area (m^2)	
Albyberg	800000	
Brandbergens Företagsby	6800	(68m2 per office, 100 offices)
Norrby Gärde	100000	(10Ha est)
Krigslida		Not included (possible only)
Hemfosa		Not included (possible only)
Utvidgning Jordbro	600000	Not included (possible only)

Step 2 - Allocate Commercial GFA to each district/development area

A percentage of GFA for Multi-storey developments is estimated based on the development maps and surroundings. For example, develpment in a central location is assumed to have 100% MSC. Locations outside the central areas will vary depending on description and surrounding buildings (using Google Maps).

Allocation of Area Based on OP Maps and Descriptions

Location	Type	Start	%MSC	Commercial GFA (2002 MKB)	GFA for MSC	Number of Floors (For MSC)	GFA for LRC	Notes
Jordbro	Mix	2016	NA	13000	13000	5	0	Assume all commercial in Multistorey buildings/integrated into Residential Buildings (OP Maps)
Vega								Information on commercial GFA not given.
Albyberg	Mix	2016	75%	800000	600000	4	200000	
Brandbergens Företagsby	Mix	2016	75%	6800	5100	4	1700	
Norrby Gärde	Mix	2016	75%	100000	75000	4	25000	

c) Huddinge

Huddinge Commercial

Summary of Information Available

Gross Floor Area (GFA) of significant commercial development areas
Preliminary Design Drawings

Step 1 - Summarise Available Information from Municipal Plans

Significant Commercial Areas Based on Ops, Plans, Website

	Total GFA (OPs)
Storängen	72 000
Huddinge Centrum	32 600
Flemingsberg	160 000
Kungens Kurva	790 000

Step 2 - Allocate the total GFA between Multi-Storey Commercial (MSC, such as offices) and Low-Rise Commercial (LRC, such as Industrial, Trade, Municipal Services etc)

This is done by either obtaining them directly from the Municipal Plan's descriptions or from measurement of the preliminary drawings for the development areas
Where the numer of storeys for MSC are not given in the OP, the number has been assumed based on surrounding buildings. This is in line with a common statement in the OP which says that the appearance of the area should not be adversely impacted and the existing theme should be maintained.

		Offices in buildings (MSC)		Ind/Comm/Ser (LRC)	
	Total GFA (OPs)	Gross Area	Number of Floors	Gross Plan Area	
Storängen	72 000	53875	5	18 125	Preliminary plan available
Huddinge Centrum	32 600	20800	6	11 800	Obtained from description and Huddinge Centrum development map
Flemingsberg	160 000	144000	5	16 000	Preliminary Plan available
Kungens Kurva	790 000	632000	4	158 000	Prelminary Plan available

Remaining Commercial Development Based on map areas and OP Description
Due to limited information, this has been omitted from the ESAR estimation

Appendix 3: Soil and Rock Types for Development Areas

a) Botkyrka

Botkyrka ArcMAP ESAR %

Legend

Rock	Granite, Granodiorite, Greywacke, Sandstone	
Cohesive Soil	Glacial and Postglacial Clays and Silts, Gyttja Clay, Glaciofluvial sediment	
Granular Soil	Glacial and Postglacial Sands and Gravels, Glaciofluvial sands and gravels	
Moraine (Till)	% of rock	30% (Refer to Soil and Rock QTYs Tab)
Others (Artificial Fill/Peat)		

Slagsta Strand

OBJECTID *	Shape *	JG2	JG2_TX	KARTERING	KARTTYP	SYMBOL	Shape_Length	Shape_Area
1	Polygon	890	Urberg	jogi_10isv	4	121	166,37173	1837,640625
2	Polygon	890	Urberg	jogi_10isv	4	121	1004,121635	53392,97043
3	Polygon	890	Urberg	jogi_10isv	4	121	257,550233	3874,087979
4	Polygon	890	Urberg	jogi_10isv	4	121	155,370455	1738,890625
5	Polygon	22	Postglacial grovlera	jogi_10isv	4	222	1014,521439	17216,04001
6	Polygon	95	Sandig morän	jogi_10isv	4	229	537,437576	8352,230801
7	Polygon	890	Urberg	jogi_10isv	4	121	209,191102	681,556355
8	Polygon	28	Postglacial finsand	jogi_10isv	4	35	866,681613	20894,73231
9	Polygon	19	Postglacial finlera	jogi_10isv	4	221	1534,118201	81323,20148
10	Polygon	31	Postglacial sand	jogi_10isv	4	9	145,460666	771,382978
11	Polygon	55	Isälvssediment, sand	jogi_10isv	4	18	364,435038	7371,948773
12	Polygon	95	Sandig morän	jogi_10isv	4	229	235,980672	3856,390625
13	Polygon	95	Sandig morän	jogi_10isv	4	229	547,012039	8424,07152
14	Polygon	40	Glacial lera	jogi_10isv	4	227	1291,508688	76127,82524
15	Polygon	890	Urberg	jogi_10isv	4	121	143,896061	1401,609375
16	Polygon	28	Postglacial finsand	jogi_10isv	4	35	1050,845805	22130,84387
								309395,423

Rock	Granular Soil	Till	Cohesive Soil	Others	
62926,75539	51168,90793	20632,69295	174667,0667	0	309395,4
20,3%	16,5%	6,7%	56,5%	0,0%	100,0%

Hallunda/Fittja

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	890	Urberg	jogi_10isv	4	121	184,612971	1006,9688
2	Polygon	95	Sandig morän	jogi_botky	2	229	733,71993	13264,622
3	Polygon	40	Glacial lera	jogi_botky	2	227	951,343244	39838,594
4	Polygon	890	Urberg	jogi_botky	2	121	103,222114	635,31573
5	Polygon	22	Postglacial grovlera	jogi_10isv	4	222	1412,18199	68401,61
6	Polygon	95	Sandig morän	jogi_10isv	4	229	133,725808	1146,8281
7	Polygon	40	Glacial lera	jogi_botky	2	227	992,793021	46746,194
8	Polygon	40	Glacial lera	jogi_10isv	4	227	527,830289	15461,567
9	Polygon	890	Urberg	jogi_botky	2	121	204,370766	2619,3125
10	Polygon	31	Postglacial sand	jogi_botky	2	9	155,540832	1022,3623
11	Polygon	19	Postglacial finlera	jogi_10isv	4	221	995,991987	41562,25
12	Polygon	17	Postglacial lera	jogi_botky	2	916	1310,59313	105886,56
13	Polygon	890	Urberg	jogi_10isv	4	121	237,49296	4165,3281
14	Polygon	890	Urberg	jogi_10isv	4	121	85,842686	352,86243
15	Polygon	890	Urberg	jogi_botky	2	121	125,202863	1038,4187
								343148,79

Rock	Granular Soil	Till	Cohesive Soil	Others	
9818,206241	1022,362306	14411,45	317896,7744	0	343149
2,9%	0,3%	4,2%	92,6%	0,0%	100,0%

Fittja

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	40	Glacial lera	jogi_botky	2	227	510,92528	3077,6273
2	Polygon	31	Postglacial sand	jogi_botky	2	9	1040,28362	22868,016
3	Polygon	890	Urberg	jogi_10isv	4	121	82,620914	328,11512
4	Polygon	890	Urberg	jogi_botky	2	121	150,817128	1570,1267
5	Polygon	890	Urberg	jogi_botky	2	121	98,335454	648,70313
6	Polygon	24	Postglacial silt	jogi_10isv	4	134	4,408548	0,773715
7	Polygon	890	Urberg	jogi_botky	2	121	292,340362	5098,375
8	Polygon	24	Postglacial silt	jogi_botky	2	134	429,850629	5966,7827
9	Polygon	24	Postglacial silt	jogi_10isv	4	134	107,247965	335,04688
10	Polygon	95	Sandig morän	jogi_botky	2	229	358,11651	2964,5348
11	Polygon	40	Glacial lera	jogi_10isv	4	227	287,250484	3600,6595
12	Polygon	890	Urberg	jogi_10isv	4	121	123,513779	927,64063
13	Polygon	890	Urberg	jogi_botky	2	121	169,043583	1789,0781
14	Polygon	95	Sandig morän	jogi_botky	2	229	519,621448	9249,2552
15	Polygon	890	Urberg	jogi_botky	2	121	183,841431	2143,8508
16	Polygon	17	Postglacial lera	jogi_botky	2	916	1423,04414	69886,915
17	Polygon	890	Urberg	jogi_botky	2	121	437,38641	11878,203
18	Polygon	24	Postglacial silt	jogi_10isv	4	134	258,080784	1592,9706
19	Polygon	95	Sandig morän	jogi_botky	2	229	1109,11924	20821,203
20	Polygon	31	Postglacial sand	jogi_botky	2	9	695,78585	10084,22
21	Polygon	55	Isälvssediment, sand	jogi_botky	2	18	739,732823	18745,563
22	Polygon	55	Isälvssediment, sand	jogi_10isv	4	18	437,710033	4269,9654
23	Polygon	890	Urberg	jogi_botky	2	121	199,807785	1690,9827
24	Polygon	95	Sandig morän	jogi_botky	2	229	941,761256	27694,099
25	Polygon	890	Urberg	jogi_botky	2	121	355,229663	8073,0911
26	Polygon	17	Postglacial lera	jogi_botky	2	916	395,168642	10918,484
27	Polygon	24	Postglacial silt	jogi_botky	2	134	2148,36106	72863,768
								319088,05

Rock	Granular Soil	Till	Cohesive Soil	Others	
34148,16643	55967,76332	60729,092	168243,0281	0	319088
10,7%	17,5%	19,0%	52,7%	0,0%	100,0%

Hallunda

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	890	Urberg	jogi_botky	2	121	29,235887	2,516712
2	Polygon	40	Glacial lera	jogi_10isv	4	227	1425,04237	63044,01
3	Polygon	95	Sandig morän	jogi_10isv	4	229	115,620429	758,51432
4	Polygon	95	Sandig morän	jogi_10isv	4	229	2653,32848	69883,745
5	Polygon	890	Urberg	jogi_10isv	4	121	333,972594	7014,2692
6	Polygon	40	Glacial lera	jogi_10isv	4	227	646,522998	11649,516
7	Polygon	890	Urberg	jogi_10isv	4	121	217,953462	3418,5469
8	Polygon	890	Urberg	jogi_10isv	4	121	1203,55663	44348,533
9	Polygon	890	Urberg	jogi_10isv	4	121	55,186988	145,07972
10	Polygon	890	Urberg	jogi_10isv	4	121	489,672297	14207,9
11	Polygon	19	Postglacial finlera	jogi_10isv	4	221	1783,56131	120899,13
12	Polygon	890	Urberg	jogi_10isv	4	121	224,788708	3658,4531
13	Polygon	33	Svallsediment, grus	jogi_10isv	4	10	352,838267	6256,7714
								345286,99

Rock	Granular Soil	Till	Cohesive Soil	Others	
72795,29878	6256,771415	70642,259	195592,6596	0	345287
21,1%	**1,8%**	**20,5%**	**56,6%**	**0,0%**	100,0%

Eriksberg (A)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	17	Postglacial lera	jogi_botky	2	916	720,951258	3948,9503
2	Polygon	890	Urberg	jogi_botky	2	121	308,550379	4046,3343
3	Polygon	95	Sandig morän	jogi_botky	2	229	287,327909	4486,7014
4	Polygon	200	Fyllning	jogi_botky	2	921	120,450492	1096,7344
5	Polygon	33	Svallsediment, grus	jogi_botky	2	10	348,970449	4072,7031
6	Polygon	890	Urberg	jogi_botky	2	121	1286,16408	82696,172
7	Polygon	95	Sandig morän	jogi_10isv	4	229	861,68678	18902,936
8	Polygon	95	Sandig morän	jogi_botky	2	229	426,463356	5501,6295
9	Polygon	17	Postglacial lera	jogi_botky	2	916	1479,03827	67775,321
10	Polygon	890	Urberg	jogi_10isv	4	121	188,748196	2017,0819
11	Polygon	24	Postglacial silt	jogi_botky	2	134	991,166689	41494,97
12	Polygon	890	Urberg	jogi_botky	2	121	684,510986	21478,911
13	Polygon	95	Sandig morän	jogi_botky	2	229	138,418875	743,89063
14	Polygon	890	Urberg	jogi_10isv	4	121	691,559925	21308,531
15	Polygon	40	Glacial lera	jogi_botky	2	227	1106,58187	42319,382
16	Polygon	19	Postglacial finlera	jogi_10isv	4	221	648,985223	23697,502
								345587,75

Rock	Granular Soil	Till	Cohesive Soil	Others	
131547,0307	4072,703125	29635,157	179236,1254	1096,7344	345588
38,1%	**1,2%**	**8,6%**	**51,9%**	**0,3%**	100,0%

Alby

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	17	Postglacial lera	jogi_botky	2	916	2598,99871	222215,26
2	Polygon	40	Glacial lera	jogi_botky	2	227	1186,73212	58738,834
3	Polygon	890	Urberg	jogi_botky	2	121	173,038497	2001,2656
4	Polygon	890	Urberg	jogi_botky	2	121	154,008685	1495,0469
5	Polygon	95	Sandig morän	jogi_botky	2	229	403,991949	5207,3281
6	Polygon	890	Urberg	jogi_botky	2	121	93,050283	271,21907
7	Polygon	95	Sandig morän	jogi_botky	2	229	1053,8583	13308,766
8	Polygon	890	Urberg	jogi_botky	2	121	128,088758	945,75
9	Polygon	890	Urberg	jogi_botky	2	121	684,010642	18335,438
								322518,91

Rock	Granular Soil	Till	Cohesive Soil	Others	
23048,71907	0	18516,094	280954,0947	0	322519
7,1%	**0,0%**	**5,7%**	**87,1%**	**0,0%**	100,0%

Eriksberg (B)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	17	Postglacial lera	jogi_botky	2	916	3500,7298	175778
2	Polygon	890	Urberg	jogi_botky	2	121	184,979993	1992,8478
3	Polygon	95	Sandig morän	jogi_botky	2	229	179,386773	1222,8919
4	Polygon	890	Urberg	jogi_botky	2	121	708,547652	18449,609
5	Polygon	200	Fyllning	jogi_botky	2	921	1412,56889	69457,031
6	Polygon	5	Kärrtorv	jogi_botky	2	2	825,922289	38583,839
7	Polygon	890	Urberg	jogi_botky	2	121	312,202997	6154,7344
8	Polygon	890	Urberg	jogi_botky	2	121	210,077159	2632,9219
9	Polygon	95	Sandig morän	jogi_botky	2	229	956,366581	20956,515
10	Polygon	890	Urberg	jogi_botky	2	121	194,36359	2727,4844
11	Polygon	24	Postglacial silt	jogi_botky	2	134	507,332214	10699,688
								348655,56

Rock	Granular Soil	Till	Cohesive Soil	Others	
31957,59783	0	22179,407	186477,689	108040,87	348656
9,2%	**0,0%**	**6,4%**	**53,5%**	**31,0%**	100,0%

Stråket Kring (A)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	17	Postglacial lera	jogi_botky	2	916	3580,94935	248405,13
2	Polygon	890	Urberg	jogi_botky	2	121	232,707443	3115,625
3	Polygon	95	Sandig morän	jogi_botky	2	229	116,394762	668,03125
4	Polygon	890	Urberg	jogi_botky	2	121	282,03919	5155,4375
5	Polygon	95	Sandig morän	jogi_botky	2	229	428,057408	5218,4241
6	Polygon	95	Sandig morän	jogi_botky	2	229	484,068984	7911,0368
7	Polygon	890	Urberg	jogi_botky	2	121	275,070016	5014,5313
8	Polygon	890	Urberg	jogi_botky	2	121	1212,09517	49311,232
9	Polygon	95	Sandig morän	jogi_botky	2	229	331,742557	4286,1094
10	Polygon	95	Sandig morän	jogi_botky	2	229	87,797535	585
								329670,55

Rock	Granular Soil	Till	Cohesive Soil	Others	
62596,82601	0	18668,602	248405,127	0	329671
19,0%	**0,0%**	**5,7%**	**75,3%**	**0,0%**	100,0%

Stråket Kring (B)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYI	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	17	Postglacial lera	jogi_botky	2	916	718,110113	13737,852
2	Polygon	890	Urberg	jogi_botky	2	121	353,509637	3146,0535
3	Polygon	95	Sandig morän	jogi_10isv	4	229	252,990596	3318,4219
4	Polygon	40	Glacial lera	jogi_10isv	4	227	184,955017	1263,3125
5	Polygon	890	Urberg	jogi_10isv	4	121	288,957413	4261,8092
6	Polygon	95	Sandig morän	jogi_10isv	4	229	358,380122	6761,9688
7	Polygon	95	Sandig morän	jogi_10isv	4	229	1859,72383	43320,719
8	Polygon	95	Sandig morän	jogi_10isv	4	229	147,133642	996,4375
9	Polygon	890	Urberg	jogi_10isv	4	121	141,587294	1401,7031
10	Polygon	890	Urberg	jogi_botky	2	121	505,396822	15655,368
11	Polygon	890	Urberg	jogi_10isv	4	121	665,913864	26775,918
12	Polygon	890	Urberg	jogi_10isv	4	121	611,831502	20853,757
13	Polygon	22	Postglacial grovlera	jogi_10isv	4	222	2160,97937	63123,405
14	Polygon	890	Urberg	jogi_10isv	4	121	403,63422	6245,1094
15	Polygon	95	Sandig morän	jogi_botky	2	229	1212,34484	17437,018
16	Polygon	40	Glacial lera	jogi_botky	2	227	1209,69352	32587,801
17	Polygon	890	Urberg	jogi_botky	2	121	47,500216	92,868277
18	Polygon	95	Sandig morän	jogi_botky	2	229	217,493242	1592,5653
19	Polygon	890	Urberg	jogi_botky	2	121	1609,41352	75983,358
20	Polygon	890	Urberg	jogi_10isv	4	121	2103,95244	76345,185
21	Polygon	19	Postglacial finlera	jogi_10isv	4	221	234,962322	1997,76
22	Polygon	95	Sandig morän	jogi_botky	2	229	328,196324	4651,125
23	Polygon	95	Sandig morän	jogi_botky	2	229	54,010487	145,91808
24	Polygon	17	Postglacial lera	jogi_botky	2	916	524,038026	14414,766
25	Polygon	95	Sandig morän	jogi_botky	2	229	198,836059	2250,125
26	Polygon	890	Urberg	jogi_10isv	4	121	227,589685	3139,6875
								441500,01

Rock	Granular Soil	Till	Cohesive Soil	Others	
233900,8175	0	80474,299	127124,8961	0	441500
53,0%	**0,0%**	**18,2%**	**28,8%**	**0,0%**	100,0%

Tumba C

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYI	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	890	Urberg	jogi_10isv	4	121	381,95861	7831,5562
2	Polygon	890	Urberg	jogi_10isv	4	121	427,101785	9842,5313
3	Polygon	95	Sandig morän	jogi_10isv	4	229	557,545072	14616,828
4	Polygon	95	Sandig morän	jogi_10isv	4	229	107,342109	246,72632
5	Polygon	9	Svämsediment, ler--silt	jogi_10isv	4	217	1073,00029	36587,289
6	Polygon	890	Urberg	jogi_10isv	4	121	471,342228	12195,119
7	Polygon	28	Postglacial finsand	jogi_10isv	4	35	416,239785	7805,0042
8	Polygon	19	Postglacial finlera	jogi_10isv	4	221	3911,60922	270633,41
9	Polygon	95	Sandig morän	jogi_10isv	4	229	120,40145	327,23051
10	Polygon	95	Sandig morän	jogi_10isv	4	229	272,803232	3609,9127
11	Polygon	890	Urberg	jogi_10isv	4	121	392,59058	7647,5156
12	Polygon	890	Urberg	jogi_10isv	4	121	216,970495	705,12428
13	Polygon	95	Sandig morän	jogi_10isv	4	229	740,929383	19733,875
14	Polygon	890	Urberg	jogi_10isv	4	121	140,13434	891,87487
15	Polygon	6	Gyttja	jogi_10isv	4	3	424,750128	9628,5942
16	Polygon	95	Sandig morän	jogi_10isv	4	229	782,953508	17979,767
17	Polygon	890	Urberg	jogi_10isv	4	121	184,545879	2456,6719
								422739,03

Rock	Granular Soil	Till	Cohesive Soil	Others	
41570,39281	7805,004168	56514,34	316849,2935	0	422739
9,8%	**1,8%**	**13,4%**	**75,0%**	**0,0%**	100,0%

Storvreten

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYI	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	890	Urberg	jogi_10isv	4	121	177,250147	1923,2188
2	Polygon	95	Sandig morän	jogi_10isv	4	229	508,674153	9349,375
3	Polygon	890	Urberg	jogi_10isv	4	121	340,424548	8902,7344
4	Polygon	95	Sandig morän	jogi_10isv	4	229	143,147814	667,26566
5	Polygon	890	Urberg	jogi_10isv	4	121	246,785989	3291,8204
6	Polygon	890	Urberg	jogi_10isv	4	121	176,579961	2192,5747
7	Polygon	890	Urberg	jogi_10isv	4	121	210,435704	2737,5938
8	Polygon	95	Sandig morän	jogi_10isv	4	229	2229,2098	49759,974
9	Polygon	890	Urberg	jogi_10isv	4	121	178,246694	2052,8281
10	Polygon	890	Urberg	jogi_10isv	4	121	217,993731	2640,604
11	Polygon	28	Postglacial finsand	jogi_10isv	4	35	759,333587	21382,794
12	Polygon	95	Sandig morän	jogi_10isv	4	229	981,387434	25247,397
13	Polygon	28	Postglacial finsand	jogi_10isv	4	35	805,024978	29460,047
14	Polygon	890	Urberg	jogi_10isv	4	121	820,713561	30577,668
15	Polygon	890	Urberg	jogi_10isv	4	121	293,40154	6517,7813
16	Polygon	890	Urberg	jogi_10isv	4	121	852,37806	46145,343
17	Polygon	890	Urberg	jogi_10isv	4	121	252,264772	3846,9063
18	Polygon	40	Glacial lera	jogi_10isv	4	227	3531,81273	139597,6
19	Polygon	890	Urberg	jogi_10isv	4	121	393,230139	8586,6214
20	Polygon	890	Urberg	jogi_10isv	4	121	552,816697	17178,328
21	Polygon	95	Sandig morän	jogi_10isv	4	229	907,241262	15049,776
22	Polygon	890	Urberg	jogi_10isv	4	121	151,527159	1634,4063
								428742,66

Rock	Granular Soil	Till	Cohesive Soil	Others	
138228,4286	50842,84123	100073,79	139597,5994	0	428743
32,2%	**11,9%**	**23,3%**	**32,6%**	**0,0%**	100,0%

Dalvägen

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYI	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	890	Urberg	jogi_10isv	4	121	374,197158	7391,7553
2	Polygon	28	Postglacial finsand	jogi_10isv	4	35	1542,68984	91932,363
3	Polygon	50	Isälvssediment	jogi_10isv	4	16	862,464556	33623,332
4	Polygon	28	Postglacial finsand	jogi_10isv	4	35	1160,46035	43950,296
5	Polygon	890	Urberg	jogi_10isv	4	121	207,615733	3183,1094
6	Polygon	95	Sandig morän	jogi_10isv	4	229	255,852159	3869,2656
7	Polygon	890	Urberg	jogi_10isv	4	121	418,599202	11204,375
8	Polygon	890	Urberg	jogi_10isv	4	121	498,273241	12320,412
9	Polygon	95	Sandig morän	jogi_10isv	4	229	1844,42413	35152,522
10	Polygon	890	Urberg	jogi_10isv	4	121	151,057853	1338,5722
11	Polygon	28	Postglacial finsand	jogi_10isv	4	35	627,445121	17436,391
12	Polygon	95	Sandig morän	jogi_10isv	4	229	194,271133	2346,0313
13	Polygon	95	Sandig morän	jogi_10isv	4	229	244,954914	2775,6291
14	Polygon	40	Glacial lera	jogi_10isv	4	227	2174,84092	182876,51
15	Polygon	890	Urberg	jogi_10isv	4	121	89,416736	69,334889
								449469,9

Rock	Granular Soil	Till	Cohesive Soil	Others	
35507,55874	153319,0496	44143,448	216499,8435	0	449470
7,9%	**34,1%**	**9,8%**	**48,2%**	**0,0%**	100,0%

Norra Kassmyra Grustag

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	31	Postglacial sand	jogi_10isv	4	9	577,16434	10368,878
2	Polygon	40	Glacial lera	jogi_10isv	4	227	110,525227	497,71696
3	Polygon	57	Isälvssediment, grus	jogi_10isv	4	19	1694,24464	156366,2
4	Polygon	55	Isälvssediment, sand	jogi_10isv	4	18	1088,06128	26817,282
5	Polygon	5	Kärrtorv	jogi_10isv	4	2	263,450908	2674,0085
6	Polygon	55	Isälvssediment, sand	jogi_10isv	4	18	2573,74435	217291,2
7	Polygon	57	Isälvssediment, grus	jogi_10isv	4	19	780,649119	33807,194
								447822,47

Rock	Granular Soil	Till	Cohesive Soil	Others	
0	444650,7477	0	497,716961	2674,0085	447822
0,0%	**99,3%**	**0,0%**	**0,1%**	**0,6%**	100,0%

Rikstens Företagspark

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	95	Sandig morän	jogi_10isv	4	229	2925,55581	62466,512
2	Polygon	890	Urberg	jogi_10isv	4	121	84,770376	195,90549
3	Polygon	890	Urberg	jogi_10isv	4	121	1199,335	57360,011
4	Polygon	95	Sandig morän	jogi_10isv	4	229	299,336305	1960,0023
5	Polygon	890	Urberg	jogi_10isv	4	121	751,110533	30621,117
6	Polygon	890	Urberg	jogi_10isv	4	121	1655,6125	79406,615
7	Polygon	890	Urberg	jogi_10isv	4	121	287,403248	3925,1652
8	Polygon	890	Urberg	jogi_10isv	4	121	40,688554	32,312867
9	Polygon	40	Glacial lera	jogi_10isv	4	227	563,847293	13599,513
10	Polygon	28	Postglacial finsand	jogi_10isv	4	35	187,616428	970,24592
11	Polygon	95	Sandig morän	jogi_10isv	4	229	767,355121	13139,976
12	Polygon	1	Mossetorv	jogi_10isv	4	1	372,17501	5404,6428
								269082,02

Rock	Granular Soil	Till	Cohesive Soil	Others	
171541,1273	970,245916	77566,491	13599,51307	5404,6428	269082
63,8%	**0,4%**	**28,8%**	**5,1%**	**2,0%**	100,0%

Tullinge C

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	40	Glacial lera	jogi_10isv	4	227	1030,78158	21026,421
2	Polygon	890	Urberg	jogi_10isv	4	121	470,688812	11710,215
3	Polygon	890	Urberg	jogi_10isv	4	121	247,610943	3833,7201
4	Polygon	890	Urberg	jogi_10isv	4	121	182,067925	2167,7813
5	Polygon	890	Urberg	jogi_10isv	4	121	362,5758	7357,1406
6	Polygon	28	Postglacial finsand	jogi_10isv	4	35	496,165716	11377,123
7	Polygon	95	Sandig morän	jogi_10isv	4	229	613,122802	7237,3819
8	Polygon	40	Glacial lera	jogi_10isv	4	227	1768,07753	58203,857
9	Polygon	28	Postglacial finsand	jogi_10isv	4	35	1064,20382	20056,898
10	Polygon	19	Postglacial finlera	jogi_10isv	4	221	1584,21956	107988,91
11	Polygon	890	Urberg	jogi_10isv	4	121	83,295462	85,685132
12	Polygon	890	Urberg	jogi_10isv	4	121	141,307057	1375,0525
13	Polygon	890	Urberg	jogi_10isv	4	121	471,320653	16121,688
								268541,87

Rock	Granular Soil	Till	Cohesive Soil	Others	
42651,28182	31434,0206	7237,3819	187219,187	0	268542
15,9%	**11,7%**	**2,7%**	**69,7%**	**0,0%**	100,0%

b) Haninge

Haninge ARCGIS ESAR %

Legend

Rock	Granite, Granodiorite, Greywacke, Sandstone	
Cohesive Soil	Glacial and Postglacial Clays and Silts, Gyttja Clay, Glaciofluvial sediment	
Granular Soil	Glacial and Postglacial Sands and Gravels, Glaciofluvial sands and gravels	
Moraine (Till)	% of rock	30% (Refer to Soil and Rock QTYs Tab)
Others (Artificial Fill/Peat)		

Vega

OBJECTID *	Shape *	JG2	JG2_TX	KARTERING	KARTTYP	SYMBOL	Shape_Length	Shape_Area
9	Polygon	40	Glacial lera	jogi_10i01	2	227	17678,08439	393148,8254
16	Polygon	40	Glacial lera	jogi_10i01	2	227	1469,647291	31010,61402
40	Polygon	40	Glacial lera	jogi_10i01	2	227	608,491372	13759,02716
42	Polygon	40	Glacial lera	jogi_10i01	2	227	234,811617	1928,724067
44	Polygon	40	Glacial lera	jogi_10i01	2	227	1993,013621	60189,53252
11	Polygon	16	Gyttjelera (eller lergyttj	jogi_10i01	2	4	16,707972	11,652355
33	Polygon	16	Gyttjelera (eller lergyttj	jogi_10i01	2	4	814,261104	17168,5123
8	Polygon	50	Isälvssediment	jogi_10i01	2	16	291,417948	1958,952298
39	Polygon	50	Isälvssediment	jogi_10i01	2	16	453,744915	5239,754848
49	Polygon	5	Kärrtorv	jogi_10i01	2	2	901,561626	18574,73016
22	Polygon	28	Postglacial finsand	jogi_10i01	2	35	137,970184	618,574406
20	Polygon	17	Postglacial lera	jogi_10i01	2	916	2098,117208	97508,04549
21	Polygon	17	Postglacial lera	jogi_10i01	2	916	510,33043	2514,394839
30	Polygon	17	Postglacial lera	jogi_10i01	2	916	1014,921648	14565,40329
2	Polygon	31	Postglacial sand	jogi_10i01	2	9	279,499405	1581,390204
28	Polygon	31	Postglacial sand	jogi_10i01	2	9	2201,963061	40666,48745
43	Polygon	31	Postglacial sand	jogi_10i01	2	9	901,223724	11436,91897
47	Polygon	31	Postglacial sand	jogi_10i01	2	9	589,566231	15390,9728
5	Polygon	95	Sandig morän	jogi_10i01	2	229	1586,653299	23212,23304
6	Polygon	95	Sandig morän	jogi_10i01	2	229	746,494817	7732,118513
1	Polygon	890	Urberg	jogi_10i01	2	121	221,698457	3462,3094
3	Polygon	890	Urberg	jogi_10i01	2	121	89,927096	564,45874
4	Polygon	890	Urberg	jogi_10i01	2	121	844,715171	32572,525
7	Polygon	890	Urberg	jogi_10i01	2	121	2245,85505	95945,093
10	Polygon	890	Urberg	jogi_10i01	2	121	685,675884	11420,64
12	Polygon	890	Urberg	jogi_10i01	2	121	545,626934	9916,6001
13	Polygon	890	Urberg	jogi_10i01	2	121	183,123849	2379,3184
14	Polygon	890	Urberg	jogi_10i01	2	121	367,668383	6392,4966
15	Polygon	890	Urberg	jogi_10i01	2	121	181,354299	2137,9417
17	Polygon	890	Urberg	jogi_10i01	2	121	358,376337	5698,822
18	Polygon	890	Urberg	jogi_10i01	2	121	139,99027	911,51326
19	Polygon	890	Urberg	jogi_10i01	2	121	2082,43952	91353,653
23	Polygon	890	Urberg	jogi_10i01	2	121	408,444509	10124,858
24	Polygon	890	Urberg	jogi_10i01	2	121	72,021777	372,43566
25	Polygon	890	Urberg	jogi_10i01	2	121	394,850169	9673,8909
26	Polygon	890	Urberg	jogi_10i01	2	121	1571,24159	135465,42
27	Polygon	890	Urberg	jogi_10i01	2	121	517,412802	4932,1523
29	Polygon	890	Urberg	jogi_10i01	2	121	113,293183	876,95158
31	Polygon	890	Urberg	jogi_10i01	2	121	72,464646	369,7938
32	Polygon	890	Urberg	jogi_10i01	2	121	3347,04641	234273,9
34	Polygon	890	Urberg	jogi_10i01	2	121	839,767134	22907,995
35	Polygon	890	Urberg	jogi_10i01	2	121	96,605141	599,38441
36	Polygon	890	Urberg	jogi_10i01	2	121	61,688147	85,614038
37	Polygon	890	Urberg	jogi_10i01	2	121	2838,92765	83702,58
38	Polygon	890	Urberg	jogi_10i01	2	121	260,252169	5014,734
41	Polygon	890	Urberg	jogi_10i01	2	121	3595,37718	274037,82
45	Polygon	890	Urberg	jogi_10i01	2	121	1514,98779	58848,369
46	Polygon	890	Urberg	jogi_10i01	2	121	2402,31499	136599,66
48	Polygon	890	Urberg	jogi_10i01	2	121	239,881848	3806,9066
								2002664,7

Rock	Granular Soil	Till	Cohesive Soil	Others	
1244447,839	69694,34383	30944,35155	639003,4386	18574,73016	2002664,7
62,1%	**3,5%**	**1,5%**	**31,9%**	**0,9%**	100,0%

Handen

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYI	SYMBO	Shape_Lengt	Shape_Area
14	Polygon	40	Glacial lera	jogi_10i01	2	227	1427,75287	59557,239
15	Polygon	40	Glacial lera	jogi_10i01	2	227	724,999524	10797,886
17	Polygon	55	Isälvssediment, sand	jogi_10i01	2	18	11635,9699	1618096,3
6	Polygon	5	Kärrtorv	jogi_10i01	2	2	638,016376	5361,2555
13	Polygon	5	Kärrtorv	jogi_10i01	2	2	343,808504	2409,5331
5	Polygon	1	Mossetorv	jogi_10i01	2	1	908,768746	12993,612
8	Polygon	31	Postglacial sand	jogi_10i01	2	9	645,524341	6201,4551
1	Polygon	890	Urberg	jogi_10i01	2	121	169,392487	1856,9939
2	Polygon	890	Urberg	jogi_10i01	2	121	2075,11636	136745,64
3	Polygon	890	Urberg	jogi_10i01	2	121	469,015407	16069,537
4	Polygon	890	Urberg	jogi_10i01	2	121	135,713742	1361,4997
7	Polygon	890	Urberg	jogi_10i01	2	121	133,384782	920,29665
9	Polygon	890	Urberg	jogi_10i01	2	121	60,733499	140,56345
10	Polygon	890	Urberg	jogi_10i01	2	121	102,71195	566,2782
11	Polygon	890	Urberg	jogi_10i01	2	121	328,804762	6034,6487
12	Polygon	890	Urberg	jogi_10i01	2	121	96,674788	631,06871
16	Polygon	890	Urberg	jogi_10i01	2	121	649,923421	18257,066
18	Polygon	890	Urberg	jogi_10i01	2	121	418,177625	7609,2308
19	Polygon	890	Urberg	jogi_10i01	2	121	1837,96522	42462,198
								1948072,3

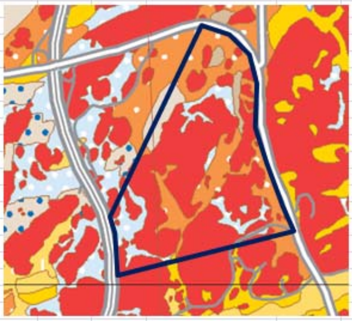
Rock	Granular Soil	Till	Cohesive Soil	Others	
232655,0257	1624297,776	0	70355,12507	20764,4	1948072
11,9%	**83,4%**	**0,0%**	**3,6%**	**1,1%**	100,0%

Jordbro

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYI	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	890	Urberg	jogi_10i01	2	121	382,783703	836,94327
2	Polygon	55	Isälvssediment, sand	jogi_10i01	2	18	3558,58879	230792,37
3	Polygon	28	Postglacial finsand	jogi_10i01	2	35	258,411204	329,03342
								231958,35

Rock	Granular Soil	Till	Cohesive Soil	Others	
836,943266	231121,4077	0	0	0	231958
0,4%	**99,6%**	**0,0%**	**0,0%**	**0,0%**	100,0%

Albyberg



Values obtained directly from soil maps

Rock	Granular Soil	Till	Cohesive Soil	Others	
62,5%	20,0%	12,5%	0,0%	5,0%	100,0%

Brandbergens Företagsby

Values obtained directly from soil maps

Rock	Granular Soil	Till	Cohesive Soil	Others	
90,0%	0,0%	0,0%	5,0%	5,0%	100,0%

Brandbergen

Values obtained directly from soil maps

Rock	Granular Soil	Till	Cohesive Soil	Others	
2,5%	2,5%	0,0%	95,0%	0,0%	100,0%

Vendelsö-Gudö

Values obtained directly from soil maps

Rock	Granular Soil	Till	Cohesive Soil	Others	
50,0%	15,0%	2,5%	27,5%	5,0%	100,0%

Tungelsta Res&Mix

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYP	SYMBO	Shape_Lengt	Shape_Area
5	Polygon	40	Glacial lera	jogi_10i01	2	227	1071,17267	49412,553
8	Polygon	40	Glacial lera	jogi_10i01	2	227	1440,37374	37646,643
6	Polygon	55	Isälvssediment, sand	jogi_10i01	2	18	735,578963	13344,206
14	Polygon	28	Postglacial finsand	jogi_10i01	2	35	145,452749	911,14928
15	Polygon	17	Postglacial lera	jogi_10i01	2	916	2775,53458	79943,204
9	Polygon	24	Postglacial silt	jogi_10i01	2	134	372,703809	4402,4815
10	Polygon	24	Postglacial silt	jogi_10i01	2	134	782,125059	11811,102
3	Polygon	9	Svämsediment, ler--silt	jogi_10i01	2	217	300,469555	5461,0193
1	Polygon	890	Urberg	jogi_10i01	2	121	57,851295	52,492316
2	Polygon	890	Urberg	jogi_10i01	2	121	283,238507	4166,2273
4	Polygon	890	Urberg	jogi_10i01	2	121	131,948466	1231,2618
7	Polygon	890	Urberg	jogi_10i01	2	121	570,367896	12838,419
11	Polygon	890	Urberg	jogi_10i01	2	121	227,011903	2563,3441
12	Polygon	890	Urberg	jogi_10i01	2	121	127,51497	935,52983
13	Polygon	890	Urberg	jogi_10i01	2	121	319,87683	5485,2377
								230204,87

Values obtained directly from soil maps

Rock	Granular Soil	Till	Cohesive Soil	Others	
27272,51236	14255,35578	0	188677,0034	0	230205
11,8%	**6,2%**	**0,0%**	**82,0%**	**0,0%**	100,0%

Norrby Gärde

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYP	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	17	Postglacial lera	jogi_10i01	2	916	2323,33603	223339,57
2	Polygon	28	Postglacial finsand	jogi_10i01	2	35	622,930071	18864,27
3	Polygon	40	Glacial lera	jogi_10i01	2	227	1391,71725	27202,676
4	Polygon	890	Urberg	jogi_10i01	2	121	50,867353	114,56624
5	Polygon	890	Urberg	jogi_10i01	2	121	332,934307	1296,684
6	Polygon	40	Glacial lera	jogi_10i01	2	227	591,645813	11144,442
7	Polygon	890	Urberg	jogi_10i01	2	121	210,766083	2103,8819
								284066,09

Values obtained directly from soil maps

Rock	Granular Soil	Till	Cohesive Soil	Others	
3515,13216	18864,26979	0	261686,6866	0	284066
1,2%	**6,6%**	**0,0%**	**92,1%**	**0,0%**	100,0%

c) Huddinge

Huddinge ARCGIS ESAR %

Legend

Rock		Granite, Granodiorite, Greywacke, Sandstone
Cohesive Soil		Glacial and Postglacial Clays and Silts, Gyttja Clay, Glaciofluvial sediment
Granular Soil		Glacial and Postglacial Sands and Gravels, Glaciofluvial sands and gravels
Moraine (Till)		% of rock 30% (Refer to Soil and Rock QTY's Tab)
	Others (Artificial Fill/Peat)	

Flemingsberg

Rock	Granular Soil	Till	Cohesive Soil	Others	
2361824,936	20539,95313	1177011,1	2140289,108	202509,73	6E+06
40,0%	**0,3%**	**19,9%**	**36,3%**	**3,4%**	100,0%

OBJECT	Shape	JG2	JG2_TX	KARTER	KART	SYM	Shape_Le	Shape_A
3	Polygon	40	Glacial lera	jogi_10isv	4	227	1571,926	47743,77
43	Polygon	40	Glacial lera	jogi_10isv	4	227	73,515269	379,65625
45	Polygon	40	Glacial lera	jogi_10isv	4	227	7404,43373	204635,73
79	Polygon	40	Glacial lera	jogi_10isv	4	227	3400,96289	111230,14
111	Polygon	40	Glacial lera	jogi_10isv	4	227	388,797253	4619,7813
150	Polygon	40	Glacial lera	jogi_10isv	4	227	1462,14866	35067,233
235	Polygon	40	Glacial lera	jogi_10isv	4	227	86,618594	235,85558
167	Polygon	16	Gyttjelera (eller lergyttja	jogi_10isv	4	4	618,214109	15299,703
233	Polygon	16	Gyttjelera (eller lergyttja	jogi_10isv	4	4	1638,99775	63596,315
10	Polygon	5	Kärrtorv	jogi_10isv	4	2	686,489411	17544,969
53	Polygon	5	Kärrtorv	jogi_10isv	4	2	560,675724	17003,018
164	Polygon	5	Kärrtorv	jogi_10isv	4	2	1682,1859	95716,428
191	Polygon	5	Kärrtorv	jogi_10isv	4	2	1134,84512	60311,063
87	Polygon	1	Mossetorv	jogi_10isv	4	1	460,475086	11341,219
118	Polygon	1	Mossetorv	jogi_10isv	4	1	92,600417	593,03125
50	Polygon	19	Postglacial finlera	jogi_10isv	4	221	714,473931	17710,188
187	Polygon	19	Postglacial finlera	jogi_10isv	4	221	2177,05515	63831,453
214	Polygon	19	Postglacial finlera	jogi_10isv	4	221	43286,8456	1575939,3
5	Polygon	95	Sandig morän	jogi_10isv	4	229	4813,1395	113497,47
8	Polygon	95	Sandig morän	jogi_10isv	4	229	151,682479	635,80194
13	Polygon	95	Sandig morän	jogi_10isv	4	229	502,95577	11067,922
15	Polygon	95	Sandig morän	jogi_10isv	4	229	191,403874	2555,1094
16	Polygon	95	Sandig morän	jogi_10isv	4	229	3874,18271	92954,531
33	Polygon	95	Sandig morän	jogi_10isv	4	229	438,829928	6005,967
39	Polygon	95	Sandig morän	jogi_10isv	4	229	531,914301	11420,297
58	Polygon	95	Sandig morän	jogi_10isv	4	229	536,709208	8524,4844
75	Polygon	95	Sandig morän	jogi_10isv	4	229	306,454223	3750,5863
76	Polygon	95	Sandig morän	jogi_10isv	4	229	1881,9478	37134,703
80	Polygon	95	Sandig morän	jogi_10isv	4	229	393,493955	5991,2855
81	Polygon	95	Sandig morän	jogi_10isv	4	229	1183,82872	20262,997
89	Polygon	95	Sandig morän	jogi_10isv	4	229	777,740867	15802,688
95	Polygon	95	Sandig morän	jogi_10isv	4	229	3478,1143	70102,563
98	Polygon	95	Sandig morän	jogi_10isv	4	229	253,958964	3438,6875
100	Polygon	95	Sandig morän	jogi_10isv	4	229	367,011669	7588,125
104	Polygon	95	Sandig morän	jogi_10isv	4	229	653,668521	11329,188
107	Polygon	95	Sandig morän	jogi_10isv	4	229	2683,35331	69048,125
119	Polygon	95	Sandig morän	jogi_10isv	4	229	382,423637	6862,7188
121	Polygon	95	Sandig morän	jogi_10isv	4	229	510,497077	8522,5625
126	Polygon	95	Sandig morän	jogi_10isv	4	229	775,472259	12501,547
130	Polygon	95	Sandig morän	jogi_10isv	4	229	483,878005	6935,0156
144	Polygon	95	Sandig morän	jogi_10isv	4	229	336,618639	6363,5469
157	Polygon	95	Sandig morän	jogi_10isv	4	229	323,181432	2376,1735
159	Polygon	95	Sandig morän	jogi_10isv	4	229	2310,90914	41160,172
171	Polygon	95	Sandig morän	jogi_10isv	4	229	1196,30733	19820,297
173	Polygon	95	Sandig morän	jogi_10isv	4	229	254,638524	3268,25
175	Polygon	95	Sandig morän	jogi_10isv	4	229	2991,0325	57665,846
189	Polygon	95	Sandig morän	jogi_10isv	4	229	344,056253	6161,375
190	Polygon	95	Sandig morän	jogi_10isv	4	229	525,948322	9597,6094
195	Polygon	95	Sandig morän	jogi_10isv	4	229	407,312002	6084,2031
199	Polygon	95	Sandig morän	jogi_10isv	4	229	138,741774	1195,9375
208	Polygon	95	Sandig morän	jogi_10isv	4	229	655,442028	13626,031
211	Polygon	95	Sandig morän	jogi_10isv	4	229	288,546882	4007,7031
212	Polygon	95	Sandig morän	jogi_10isv	4	229	2580,24108	65795,831
218	Polygon	95	Sandig morän	jogi_10isv	4	229	3748,28512	124972,8
223	Polygon	95	Sandig morän	jogi_10isv	4	229	3528,59009	69655,016
224	Polygon	95	Sandig morän	jogi_10isv	4	229	773,910809	18827,438
229	Polygon	95	Sandig morän	jogi_10isv	4	229	220,762234	2261,4281
230	Polygon	95	Sandig morän	jogi_10isv	4	229	1078,38416	22427,093
232	Polygon	95	Sandig morän	jogi_10isv	4	229	6239,75795	168591,44
234	Polygon	95	Sandig morän	jogi_10isv	4	229	577,028326	7220,4967
77	Polygon	33	Svallsediment, grus	jogi_10isv	4	10	732,737825	20539,953
1	Polygon	890	Urberg	jogi_10isv	4	121	160,647121	1865,0156
2	Polygon	890	Urberg	jogi_10isv	4	121	176,325686	2178,0905
4	Polygon	890	Urberg	jogi_10isv	4	121	491,304479	14950,906
6	Polygon	890	Urberg	jogi_10isv	4	121	614,082232	25721,188
7	Polygon	890	Urberg	jogi_10isv	4	121	329,416813	7408,6094
9	Polygon	890	Urberg	jogi_10isv	4	121	951,381794	60439,281
11	Polygon	890	Urberg	jogi_10isv	4	121	712,738605	18158,656
12	Polygon	890	Urberg	jogi_10isv	4	121	161,816078	1466,3594
14	Polygon	890	Urberg	jogi_10isv	4	121	136,822913	1368,0313
17	Polygon	890	Urberg	jogi_10isv	4	121	124,407112	1055,5
18	Polygon	890	Urberg	jogi_10isv	4	121	158,946682	1687,1406
19	Polygon	890	Urberg	jogi_10isv	4	121	130,217315	1170,625
20	Polygon	890	Urberg	jogi_10isv	4	121	219,021722	3520,9219
21	Polygon	890	Urberg	jogi_10isv	4	121	188,530873	2112,3594
22	Polygon	890	Urberg	jogi_10isv	4	121	1357,82416	29203,558
23	Polygon	890	Urberg	jogi_10isv	4	121	199,209738	2682,9375
24	Polygon	890	Urberg	jogi_10isv	4	121	200,427339	2850,8438
25	Polygon	890	Urberg	jogi_10isv	4	121	1083,29701	44556,234
26	Polygon	890	Urberg	jogi_10isv	4	121	689,393091	23037,891
27	Polygon	890	Urberg	jogi_10isv	4	121	285,035778	5721,2188
28	Polygon	890	Urberg	jogi_10isv	4	121	207,457632	3067,5
29	Polygon	890	Urberg	jogi_10isv	4	121	1201,10188	54564,016
30	Polygon	890	Urberg	jogi_10isv	4	121	202,958367	2417,9219
31	Polygon	890	Urberg	jogi_10isv	4	121	1410,59764	85283,484
32	Polygon	890	Urberg	jogi_10isv	4	121	191,369967	2694,9219
34	Polygon	890	Urberg	jogi_10isv	4	121	624,808414	22742,828
35	Polygon	890	Urberg	jogi_10isv	4	121	810,501725	30833,563
36	Polygon	890	Urberg	jogi_10isv	4	121	167,850331	2030,7656
37	Polygon	890	Urberg	jogi_10isv	4	121	218,543518	2982,5748

38	Polygon	890	Urberg	jogi_10isv	4	121	545,658935	14123,438
40	Polygon	890	Urberg	jogi_10isv	4	121	159,514098	1795
41	Polygon	890	Urberg	jogi_10isv	4	121	193,652019	2749,7656
42	Polygon	890	Urberg	jogi_10isv	4	121	983,414893	60123,547
44	Polygon	890	Urberg	jogi_10isv	4	121	175,075993	2172,7188
46	Polygon	890	Urberg	jogi_10isv	4	121	464,769538	9410,9516
47	Polygon	890	Urberg	jogi_10isv	4	121	403,7239	11012,438
48	Polygon	890	Urberg	jogi_10isv	4	121	157,985224	1485,1563
49	Polygon	890	Urberg	jogi_10isv	4	121	366,475092	8575,0625
51	Polygon	890	Urberg	jogi_10isv	4	121	766,918877	26680
52	Polygon	890	Urberg	jogi_10isv	4	121	226,780904	3736,4531
54	Polygon	890	Urberg	jogi_10isv	4	121	253,335647	4171,7656
55	Polygon	890	Urberg	jogi_10isv	4	121	193,095323	2263,2813
56	Polygon	890	Urberg	jogi_10isv	4	121	221,327937	3505,3594
57	Polygon	890	Urberg	jogi_10isv	4	121	185,435524	2443,3125
59	Polygon	890	Urberg	jogi_10isv	4	121	248,339586	3312,5156
60	Polygon	890	Urberg	jogi_10isv	4	121	407,318535	10226,018
61	Polygon	890	Urberg	jogi_10isv	4	121	166,323916	1737,7344
62	Polygon	890	Urberg	jogi_10isv	4	121	903,34623	32576,281
63	Polygon	890	Urberg	jogi_10isv	4	121	654,280526	26773,703
64	Polygon	890	Urberg	jogi_10isv	4	121	1297,49164	60756,509
65	Polygon	890	Urberg	jogi_10isv	4	121	221,749164	2901,0313
66	Polygon	890	Urberg	jogi_10isv	4	121	123,956941	1083,2813
67	Polygon	890	Urberg	jogi_10isv	4	121	510,34886	15297,391
68	Polygon	890	Urberg	jogi_10isv	4	121	432,362131	13119,922
69	Polygon	890	Urberg	jogi_10isv	4	121	253,269799	4194,0781
70	Polygon	890	Urberg	jogi_10isv	4	121	452,996588	11030,766
71	Polygon	890	Urberg	jogi_10isv	4	121	250,267106	4004,5
72	Polygon	890	Urberg	jogi_10isv	4	121	121,111469	990,03125
73	Polygon	890	Urberg	jogi_10isv	4	121	256,914828	4543,0938
74	Polygon	890	Urberg	jogi_10isv	4	121	414,210398	11523,625
78	Polygon	890	Urberg	jogi_10isv	4	121	199,215118	2770,1719
82	Polygon	890	Urberg	jogi_10isv	4	121	341,556155	8024,1245
83	Polygon	890	Urberg	jogi_10isv	4	121	84,178642	151,4875
84	Polygon	890	Urberg	jogi_10isv	4	121	340,472299	8603,3906
85	Polygon	890	Urberg	jogi_10isv	4	121	245,932607	3713,7969
86	Polygon	890	Urberg	jogi_10isv	4	121	455,107491	9465,0194
88	Polygon	890	Urberg	jogi_10isv	4	121	279,351552	4974,6094
90	Polygon	890	Urberg	jogi_10isv	4	121	809,569811	34270,016
91	Polygon	890	Urberg	jogi_10isv	4	121	365,501043	6179,0313
92	Polygon	890	Urberg	jogi_10isv	4	121	411,986818	9231,2188
93	Polygon	890	Urberg	jogi_10isv	4	121	1545,55292	64005,781
94	Polygon	890	Urberg	jogi_10isv	4	121	447,432695	12341,609
96	Polygon	890	Urberg	jogi_10isv	4	121	287,746552	5465,1719
97	Polygon	890	Urberg	jogi_10isv	4	121	445,739253	9471,1719
99	Polygon	890	Urberg	jogi_10isv	4	121	203,463757	2663,8328
101	Polygon	890	Urberg	jogi_10isv	4	121	581,445003	13670,031
102	Polygon	890	Urberg	jogi_10isv	4	121	263,234739	4447,75
103	Polygon	890	Urberg	jogi_10isv	4	121	420,209663	11835,781
105	Polygon	890	Urberg	jogi_10isv	4	121	296,141269	4400,625
106	Polygon	890	Urberg	jogi_10isv	4	121	1870,18123	114811,91
108	Polygon	890	Urberg	jogi_10isv	4	121	259,821835	4633,8594
109	Polygon	890	Urberg	jogi_10isv	4	121	204,077292	2332,3594
110	Polygon	890	Urberg	jogi_10isv	4	121	146,334412	1372,0313
112	Polygon	890	Urberg	jogi_10isv	4	121	701,543809	27553,391
113	Polygon	890	Urberg	jogi_10isv	4	121	195,747031	2359,4844
114	Polygon	890	Urberg	jogi_10isv	4	121	421,89477	11129,859
115	Polygon	890	Urberg	jogi_10isv	4	121	293,080113	4974,9375
116	Polygon	890	Urberg	jogi_10isv	4	121	177,970227	2226,5313
117	Polygon	890	Urberg	jogi_10isv	4	121	86,151403	195,4561
120	Polygon	890	Urberg	jogi_10isv	4	121	214,062745	2723,875
122	Polygon	890	Urberg	jogi_10isv	4	121	510,455192	13818,5
123	Polygon	890	Urberg	jogi_10isv	4	121	157,214264	1633,3438
124	Polygon	890	Urberg	jogi_10isv	4	121	230,351212	3192,9219
125	Polygon	890	Urberg	jogi_10isv	4	121	429,163919	12290,453
127	Polygon	890	Urberg	jogi_10isv	4	121	1737,11066	120029,31
128	Polygon	890	Urberg	jogi_10isv	4	121	804,745481	25498,031
129	Polygon	890	Urberg	jogi_10isv	4	121	716,84978	36731,047
131	Polygon	890	Urberg	jogi_10isv	4	121	280,265107	5639,9688
132	Polygon	890	Urberg	jogi_10isv	4	121	855,36385	37245,891
133	Polygon	890	Urberg	jogi_10isv	4	121	224,255583	3134,25
134	Polygon	890	Urberg	jogi_10isv	4	121	252,662844	3695
135	Polygon	890	Urberg	jogi_10isv	4	121	267,320264	5018,8125
136	Polygon	890	Urberg	jogi_10isv	4	121	509,112718	13193,163
137	Polygon	890	Urberg	jogi_10isv	4	121	355,341062	7102,0781
138	Polygon	890	Urberg	jogi_10isv	4	121	149,12541	1541,5781
139	Polygon	890	Urberg	jogi_10isv	4	121	541,87675	12907,141
140	Polygon	890	Urberg	jogi_10isv	4	121	627,765498	18032,219
141	Polygon	890	Urberg	jogi_10isv	4	121	1156,33282	53068,031
142	Polygon	890	Urberg	jogi_10isv	4	121	387,993107	9533,5
143	Polygon	890	Urberg	jogi_10isv	4	121	333,009304	6392,6094
145	Polygon	890	Urberg	jogi_10isv	4	121	1159,79534	39613,797
146	Polygon	890	Urberg	jogi_10isv	4	121	203,915837	3065,0625
147	Polygon	890	Urberg	jogi_10isv	4	121	209,432018	2460,2972
148	Polygon	890	Urberg	jogi_10isv	4	121	255,177055	3493,8734
149	Polygon	890	Urberg	jogi_10isv	4	121	224,612657	3132,9531
151	Polygon	890	Urberg	jogi_10isv	4	121	246,486891	3926,2813
152	Polygon	890	Urberg	jogi_10isv	4	121	201,437078	2823,1094
153	Polygon	890	Urberg	jogi_10isv	4	121	307,099973	5437,8281
154	Polygon	890	Urberg	jogi_10isv	4	121	244,935394	3767,5156

155	Polygon	890	Urberg	jogi_10isv	4	121	136,353215	1236,2344
156	Polygon	890	Urberg	jogi_10isv	4	121	473,245306	11249,453
158	Polygon	890	Urberg	jogi_10isv	4	121	469,562072	14260,781
160	Polygon	890	Urberg	jogi_10isv	4	121	597,038703	17575,244
161	Polygon	890	Urberg	jogi_10isv	4	121	1004,82801	35643,047
162	Polygon	890	Urberg	jogi_10isv	4	121	185,094239	2510,8125
163	Polygon	890	Urberg	jogi_10isv	4	121	306,613434	5565,5313
165	Polygon	890	Urberg	jogi_10isv	4	121	142,086002	1356,5781
166	Polygon	890	Urberg	jogi_10isv	4	121	427,610239	9103,3125
168	Polygon	890	Urberg	jogi_10isv	4	121	217,273229	2951,2813
169	Polygon	890	Urberg	jogi_10isv	4	121	998,096793	41583,188
170	Polygon	890	Urberg	jogi_10isv	4	121	226,807816	3320,4531
172	Polygon	890	Urberg	jogi_10isv	4	121	199,972897	2684,5313
174	Polygon	890	Urberg	jogi_10isv	4	121	218,871683	2976,4375
176	Polygon	890	Urberg	jogi_10isv	4	121	226,822713	3591,7188
177	Polygon	890	Urberg	jogi_10isv	4	121	250,839978	3894,7031
178	Polygon	890	Urberg	jogi_10isv	4	121	353,765512	8262,0865
179	Polygon	890	Urberg	jogi_10isv	4	121	600,892535	7077,8363
180	Polygon	890	Urberg	jogi_10isv	4	121	486,186887	17778,266
181	Polygon	890	Urberg	jogi_10isv	4	121	233,485482	3592,3281
182	Polygon	890	Urberg	jogi_10isv	4	121	200,571851	2756,8934
183	Polygon	890	Urberg	jogi_10isv	4	121	718,56656	30322,203
184	Polygon	890	Urberg	jogi_10isv	4	121	541,768392	15260,607
185	Polygon	890	Urberg	jogi_10isv	4	121	140,708059	1047,8898
186	Polygon	890	Urberg	jogi_10isv	4	121	375,529515	9017,3125
188	Polygon	890	Urberg	jogi_10isv	4	121	185,794899	2293,4375
192	Polygon	890	Urberg	jogi_10isv	4	121	839,896837	16052,422
193	Polygon	890	Urberg	jogi_10isv	4	121	2633,67268	173999,03
194	Polygon	890	Urberg	jogi_10isv	4	121	311,938193	6166,2969
196	Polygon	890	Urberg	jogi_10isv	4	121	505,731185	16013,719
197	Polygon	890	Urberg	jogi_10isv	4	121	417,361449	10235,828
198	Polygon	890	Urberg	jogi_10isv	4	121	364,332515	6966,0313
200	Polygon	890	Urberg	jogi_10isv	4	121	258,590728	556,60283
201	Polygon	890	Urberg	jogi_10isv	4	121	253,741256	4702,5313
202	Polygon	890	Urberg	jogi_10isv	4	121	1609,14321	72671,703
203	Polygon	890	Urberg	jogi_10isv	4	121	140,778288	1396,6563
204	Polygon	890	Urberg	jogi_10isv	4	121	797,46736	16978,344
205	Polygon	890	Urberg	jogi_10isv	4	121	92,977903	639,76563
206	Polygon	890	Urberg	jogi_10isv	4	121	276,389259	4319,3125
207	Polygon	890	Urberg	jogi_10isv	4	121	179,483614	2341,2031
209	Polygon	890	Urberg	jogi_10isv	4	121	891,950784	36509,391
210	Polygon	890	Urberg	jogi_10isv	4	121	177,84451	2374,375
213	Polygon	890	Urberg	jogi_10isv	4	121	339,653627	5363,1314
215	Polygon	890	Urberg	jogi_10isv	4	121	189,732854	2248,2813
216	Polygon	890	Urberg	jogi_10isv	4	121	910,782132	27408,781
217	Polygon	890	Urberg	jogi_10isv	4	121	123,477637	1046,9063
219	Polygon	890	Urberg	jogi_10isv	4	121	146,094769	1568,2969
220	Polygon	890	Urberg	jogi_10isv	4	121	260,424679	5063,0313
221	Polygon	890	Urberg	jogi_10isv	4	121	245,497789	3816,3438
222	Polygon	890	Urberg	jogi_10isv	4	121	223,486112	3261,2656
225	Polygon	890	Urberg	jogi_10isv	4	121	289,546064	5790,9844
226	Polygon	890	Urberg	jogi_10isv	4	121	150,936614	1264,5313
227	Polygon	890	Urberg	jogi_10isv	4	121	211,286878	3057,7031
228	Polygon	890	Urberg	jogi_10isv	4	121	362,916137	7621,0625
231	Polygon	890	Urberg	jogi_10isv	4	121	168,040057	1864,1719
236	Polygon	890	Urberg	jogi_10isv	4	121	48,278314	106,51561
								5902174,8

Storängen

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	16	Gyttjelera (eller lergyttja	jogi_10isv	4	4	451,459633	9892,9627
2	Polygon	5	Kärrtorv	jogi_10isv	4	2	2201,07486	177749,22
3	Polygon	6	Gyttja	jogi_10i01	2	3	367,827131	8912,3051
4	Polygon	40	Glacial lera	jogi_10isv	4	227	50,318716	65,882904
5	Polygon	16	Gyttjelera (eller lergyttja	jogi_10i01	2	4	231,586213	2424,7376
6	Polygon	890	Urberg	jogi_10i01	2	121	160,482581	673,29426
7	Polygon	5	Kärrtorv	jogi_10i01	2	2	681,971529	25313,831
8	Polygon	890	Urberg	jogi_10isv	4	121	427,476803	8797,1094
9	Polygon	890	Urberg	jogi_10isv	4	121	285,943698	4491,5283
10	Polygon	890	Urberg	jogi_10isv	4	121	200,249542	2113,2585
11	Polygon	19	Postglacial finlera	jogi_10isv	4	221	1325,47986	21804,008
12	Polygon	890	Urberg	jogi_10i01	2	121	45,668739	40,378036
13	Polygon	40	Glacial lera	jogi_10i01	2	227	123,077818	99,093505
								262377,61

Rock	Granular Soil	Till	Cohesive Soil	Others	
16115,56843	0	0	43198,99016	203063,05	262378
6,1%	**0,0%**	**0,0%**	**16,5%**	**77,4%**	100,0%

Huddinge C (Res)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
13	Polygon	40	Glacial lera	jogi_10isv	4	227	1895,35711	33440,198
35	Polygon	40	Glacial lera	jogi_10isv	4	227	264,676068	2314,9366
5	Polygon	5	Kärrtorv	jogi_10isv	4	2	2414,05541	78851,122
7	Polygon	5	Kärrtorv	jogi_10isv	4	2	1037,72118	27670,43
24	Polygon	19	Postglacial finlera	jogi_10isv	4	221	411,413427	9264,9232
30	Polygon	19	Postglacial finlera	jogi_10isv	4	221	260,691725	3678,0704
33	Polygon	19	Postglacial finlera	jogi_10isv	4	221	8292,3673	220523,63
3	Polygon	95	Sandig morän	jogi_10isv	4	229	26,393913	10,393049
34	Polygon	95	Sandig morän	jogi_10isv	4	229	895,318506	18300,605
1	Polygon	890	Urberg	jogi_10isv	4	121	221,02992	2764,568
2	Polygon	890	Urberg	jogi_10isv	4	121	252,01558	3864,5313
4	Polygon	890	Urberg	jogi_10isv	4	121	146,553824	579,0461
6	Polygon	890	Urberg	jogi_10isv	4	121	247,855651	4242,3236
8	Polygon	890	Urberg	jogi_10isv	4	121	130,916502	227,5195
9	Polygon	890	Urberg	jogi_10isv	4	121	182,768361	1354,5836
10	Polygon	890	Urberg	jogi_10isv	4	121	80,56738	103,98824
11	Polygon	890	Urberg	jogi_10isv	4	121	561,777844	13139,898
12	Polygon	890	Urberg	jogi_10isv	4	121	449,67396	13025,109
14	Polygon	890	Urberg	jogi_10isv	4	121	465,534864	12880,546
15	Polygon	890	Urberg	jogi_10isv	4	121	188,120624	1982,1743
16	Polygon	890	Urberg	jogi_10isv	4	121	248,214056	4224,3125
17	Polygon	890	Urberg	jogi_10isv	4	121	170,766311	2078,5479
18	Polygon	890	Urberg	jogi_10isv	4	121	207,334874	2680,0156
19	Polygon	890	Urberg	jogi_10isv	4	121	57,185854	103,33936
20	Polygon	890	Urberg	jogi_10isv	4	121	26,417373	12,344789
21	Polygon	890	Urberg	jogi_10isv	4	121	211,839768	2478,8604
22	Polygon	890	Urberg	jogi_10isv	4	121	422,64415	10353,494
23	Polygon	890	Urberg	jogi_10isv	4	121	516,097259	10225,975
25	Polygon	890	Urberg	jogi_10isv	4	121	105,534859	466,81148
26	Polygon	890	Urberg	jogi_10isv	4	121	520,197332	15943,738
27	Polygon	890	Urberg	jogi_10isv	4	121	332,113928	5567,3965
28	Polygon	890	Urberg	jogi_10isv	4	121	530,618057	15377,359
29	Polygon	890	Urberg	jogi_10isv	4	121	1163,42128	45103,08
31	Polygon	890	Urberg	jogi_10isv	4	121	180,237345	1092,0078
32	Polygon	890	Urberg	jogi_10isv	4	121	168,128549	1616,858
36	Polygon	890	Urberg	jogi_10isv	4	121	194,977074	2730,4844
37	Polygon	890	Urberg	jogi_10isv	4	121	67,173116	112,07867
								568385,3

Rock	Granular Soil	Till	Cohesive Soil	Others	
174330,9916	0	18310,998	269221,7545	106521,55	568385
30,7%	**0,0%**	**3,2%**	**47,4%**	**18,7%**	100,0%

Huddinge C (MSC)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
8	Polygon	40	Glacial lera	jogi_10isv	4	227	1895,35711	33440,198
23	Polygon	40	Glacial lera	jogi_10isv	4	227	264,676068	2314,9366
2	Polygon	5	Kärrtorv	jogi_10isv	4	2	2414,05541	78851,122
4	Polygon	5	Kärrtorv	jogi_10isv	4	2	1037,72118	27670,43
16	Polygon	19	Postglacial finlera	jogi_10isv	4	221	411,413427	9264,9232
19	Polygon	19	Postglacial finlera	jogi_10isv	4	221	260,691725	3678,0704
22	Polygon	19	Postglacial finlera	jogi_10isv	4	221	4680,89797	133229,02
1	Polygon	890	Urberg	jogi_10isv	4	121	146,553824	579,0461
3	Polygon	890	Urberg	jogi_10isv	4	121	247,855651	4242,3236
5	Polygon	890	Urberg	jogi_10isv	4	121	80,56738	103,98824
6	Polygon	890	Urberg	jogi_10isv	4	121	561,777844	13139,898
7	Polygon	890	Urberg	jogi_10isv	4	121	449,67396	13025,109
9	Polygon	890	Urberg	jogi_10isv	4	121	465,534864	12880,546
10	Polygon	890	Urberg	jogi_10isv	4	121	188,120624	1982,1743
11	Polygon	890	Urberg	jogi_10isv	4	121	248,214056	4224,3125
12	Polygon	890	Urberg	jogi_10isv	4	121	170,766311	2078,5479
13	Polygon	890	Urberg	jogi_10isv	4	121	211,839768	2478,8604
14	Polygon	890	Urberg	jogi_10isv	4	121	422,64415	10353,494
15	Polygon	890	Urberg	jogi_10isv	4	121	516,097259	10225,975
17	Polygon	890	Urberg	jogi_10isv	4	121	105,534859	466,81148
18	Polygon	890	Urberg	jogi_10isv	4	121	520,197332	15943,738
20	Polygon	890	Urberg	jogi_10isv	4	121	180,237345	1092,0078
21	Polygon	890	Urberg	jogi_10isv	4	121	168,128549	1616,858
24	Polygon	890	Urberg	jogi_10isv	4	121	194,977074	2730,4844
25	Polygon	890	Urberg	jogi_10isv	4	121	67,173116	112,07867
								385724,96

Rock	Granular Soil	Till	Cohesive Soil	Others	
97276,25346	0	0	181927,1509	106521,55	385725
25,2%	**0,0%**	**0,0%**	**47,2%**	**27,6%**	100,0%

Huddinge C (LRC)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
5	Polygon	40	Glacial lera	jogi_10isv	4	227	13,895079	8,909869
15	Polygon	40	Glacial lera	jogi_10i01	2	227	498,075768	8242,4423
16	Polygon	40	Glacial lera	jogi_10i01	2	227	525,8109	9234,7129
2	Polygon	16	Gyttjelera (eller lergyttja	jogi_10isv	4	4	112,945486	415,56853
6	Polygon	16	Gyttjelera (eller lergyttja	jogi_10isv	4	4	113,6526	431,95199
11	Polygon	16	Gyttjelera (eller lergyttja	jogi_10i01	2	4	1526,20381	52348,949
3	Polygon	5	Kärrtorv	jogi_10isv	4	2	508,979643	2381,229
14	Polygon	19	Postglacial finlera	jogi_10isv	4	221	1199,26891	16354,223
7	Polygon	95	Sandig morän	jogi_10isv	4	229	212,575764	1846,3608
1	Polygon	890	Urberg	jogi_10isv	4	121	82,320934	194,98182
4	Polygon	890	Urberg	jogi_10i01	2	121	162,461787	1243,3687
8	Polygon	890	Urberg	jogi_10i01	2	121	247,68595	2449,401
9	Polygon	890	Urberg	jogi_10isv	4	121	675,895878	30445,026
10	Polygon	890	Urberg	jogi_10isv	4	121	14,012865	7,309075
12	Polygon	890	Urberg	jogi_10i01	2	121	212,963515	2007,1541
13	Polygon	890	Urberg	jogi_10isv	4	121	530,46724	10405,423
								138017,01

Rock	Granular Soil	Till	Cohesive Soil	Others	
46752,6638	0	1846,3608	87036,75813	2381,229	138017
33,9%	**0,0%**	**1,3%**	**63,1%**	**1,7%**	100,0%

Stuvsta (Mix)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
8	Polygon	40	Glacial lera	jogi_10isv	4	227	1854,24603	50532,982
11	Polygon	40	Glacial lera	jogi_10i01	2	227	111,500975	754,07297
20	Polygon	40	Glacial lera	jogi_10i01	2	227	4027,51749	155553,94
19	Polygon	17	Postglacial lera	jogi_10i01	2	916	730,416397	19440,714
4	Polygon	95	Sandig morän	jogi_10isv	4	229	287,848452	1329,9053
15	Polygon	95	Sandig morän	jogi_10i01	2	229	552,387219	8094,4445
1	Polygon	890	Urberg	jogi_10isv	4	121	235,975328	2937,3508
2	Polygon	890	Urberg	jogi_10i01	2	121	317,155169	2744,3609
3	Polygon	890	Urberg	jogi_10isv	4	121	526,420831	7274,8799
5	Polygon	890	Urberg	jogi_10i01	2	121	416,295184	1666,4234
6	Polygon	890	Urberg	jogi_10isv	4	121	228,274861	2519,5781
7	Polygon	890	Urberg	jogi_10isv	4	121	227,860577	2150,9536
9	Polygon	890	Urberg	jogi_10i01	2	121	138,172609	1114,2005
10	Polygon	890	Urberg	jogi_10i01	2	121	169,052321	1570,2994
12	Polygon	890	Urberg	jogi_10i01	2	121	856,267372	8463,6163
13	Polygon	890	Urberg	jogi_10i01	2	121	669,593775	7172,8448
14	Polygon	890	Urberg	jogi_10isv	4	121	154,703312	1759,625
16	Polygon	890	Urberg	jogi_10isv	4	121	22,751139	5,611188
17	Polygon	890	Urberg	jogi_10i01	2	121	1021,19954	10574,304
18	Polygon	890	Urberg	jogi_10i01	2	121	57,187499	195,30874
21	Polygon	890	Urberg	jogi_10isv	4	121	246,121056	4045,2276
22	Polygon	890	Urberg	jogi_10i01	2	121	194,419376	1838,6282
								291739,27

Rock	Granular Soil	Till	Cohesive Soil	Others	
56033,21254	0	9424,3498	226281,7079	0	291739
19,2%	**0,0%**	**3,2%**	**77,6%**	**0,0%**	100,0%

Segeltorp (Res&Mix)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
11	Polygon	200	Fyllning	jogi_10i02	2	921	4557,10217	265928,73
12	Polygon	40	Glacial lera	jogi_10isv	4	227	1982,24914	36382,624
19	Polygon	40	Glacial lera	jogi_10i02	2	227	1607,95797	34260,707
18	Polygon	5	Kärrtorv	jogi_10isv	4	2	27,354227	19,591676
1	Polygon	890	Urberg	jogi_10i02	2	121	475,530243	1166,8657
2	Polygon	890	Urberg	jogi_10isv	4	121	299,958481	4802,471
3	Polygon	890	Urberg	jogi_10isv	4	121	174,210896	652,86769
4	Polygon	890	Urberg	jogi_10i02	2	121	372,179624	6178,5021
5	Polygon	890	Urberg	jogi_10i02	2	121	536,205462	7392,0822
6	Polygon	890	Urberg	jogi_10i02	2	121	162,139457	388,68344
7	Polygon	890	Urberg	jogi_10i02	2	121	168,518498	1886,587
8	Polygon	890	Urberg	jogi_10i02	2	121	24,338573	13,074102
9	Polygon	890	Urberg	jogi_10isv	4	121	159,22121	1627,2969
10	Polygon	890	Urberg	jogi_10i02	2	121	314,786115	3017,8525
13	Polygon	890	Urberg	jogi_10i02	2	121	195,389849	2186,7941
14	Polygon	890	Urberg	jogi_10i02	2	121	134,320908	1028,6707
15	Polygon	890	Urberg	jogi_10i02	2	121	77,950654	413,90236
16	Polygon	890	Urberg	jogi_10isv	4	121	158,408407	719,78343
17	Polygon	890	Urberg	jogi_10i02	2	121	14,478731	7,807811
								368074,9

Rock	Granular Soil	Till	Cohesive Soil	Others	
31483,241	0	0	70643,33103	265948,32	368075
8,6%	**0,0%**	**0,0%**	**19,2%**	**72,3%**	100,0%

Kungens Kurva

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
49	Polygon	40	Glacial lera	jogi_10isv	4	227	1727,08244	40450,578
83	Polygon	40	Glacial lera	jogi_10isv	4	227	5181,04293	162605,71
87	Polygon	40	Glacial lera	jogi_10isv	4	227	4158,55774	115495,2
98	Polygon	40	Glacial lera	jogi_10isv	4	227	251,151387	2505,0192
106	Polygon	16	Gyttjelera (eller lergyttja	jogi_10isv	4	4	4469,24033	151695,11
112	Polygon	57	Isälvssediment, grus	jogi_10isv	4	19	930,091144	36798,031
47	Polygon	5	Kärrtorv	jogi_10isv	4	2	1340,82907	68165,516
93	Polygon	5	Kärrtorv	jogi_10isv	4	2	535,073129	18925,219
85	Polygon	1	Mossetorv	jogi_10isv	4	1	568,691606	22889
102	Polygon	1	Mossetorv	jogi_10isv	4	1	407,067415	9701,4531
21	Polygon	19	Postglacial finlera	jogi_10isv	4	221	6602,33847	279172,53
45	Polygon	19	Postglacial finlera	jogi_10isv	4	221	124,184085	946,85938
66	Polygon	19	Postglacial finlera	jogi_10isv	4	221	8025,12325	218425,07
3	Polygon	28	Postglacial finsand	jogi_10isv	4	35	277,987346	4238,691
19	Polygon	28	Postglacial finsand	jogi_10isv	4	35	1344,89702	53279,892
69	Polygon	28	Postglacial finsand	jogi_10isv	4	35	750,801349	14184,468
68	Polygon	31	Postglacial sand	jogi_10isv	4	9	34,403727	15,599193
99	Polygon	31	Postglacial sand	jogi_10isv	4	9	137,224452	777,37455
7	Polygon	95	Sandig morän	jogi_10isv	4	229	405,134577	5897,5313
13	Polygon	95	Sandig morän	jogi_10isv	4	229	379,928631	8189,1563
29	Polygon	95	Sandig morän	jogi_10isv	4	229	212,833766	2304,5246
32	Polygon	95	Sandig morän	jogi_10isv	4	229	1295,78059	16229,259
42	Polygon	95	Sandig morän	jogi_10isv	4	229	2261,5813	47977,578
52	Polygon	95	Sandig morän	jogi_10isv	4	229	8094,70441	193425,7
55	Polygon	95	Sandig morän	jogi_10isv	4	229	477,914791	10505,313
63	Polygon	95	Sandig morän	jogi_10isv	4	229	325,264935	5787,0156
67	Polygon	95	Sandig morän	jogi_10isv	4	229	856,141929	21383,782
71	Polygon	95	Sandig morän	jogi_10isv	4	229	197,387514	2134,4122
79	Polygon	95	Sandig morän	jogi_10isv	4	229	714,144814	16334,75
88	Polygon	95	Sandig morän	jogi_10isv	4	229	1190,49592	24093,584
96	Polygon	95	Sandig morän	jogi_10isv	4	229	268,008741	2945,341
107	Polygon	95	Sandig morän	jogi_10isv	4	229	281,516447	5412,3281
114	Polygon	95	Sandig morän	jogi_10isv	4	229	62,121706	192,25614
116	Polygon	95	Sandig morän	jogi_10isv	4	229	166,388276	1668,3344
119	Polygon	95	Sandig morän	jogi_10isv	4	229	4218,98265	111504,15
1	Polygon	890	Urberg	jogi_10isv	4	121	228,312244	3144,0313
2	Polygon	890	Urberg	jogi_10isv	4	121	232,300962	3635,7188
4	Polygon	890	Urberg	jogi_10isv	4	121	288,151647	5650,218
5	Polygon	890	Urberg	jogi_10isv	4	121	210,210606	2928,2813
6	Polygon	890	Urberg	jogi_10isv	4	121	140,48898	1386,1563
8	Polygon	890	Urberg	jogi_10isv	4	121	733,549854	30099,406
9	Polygon	890	Urberg	jogi_10isv	4	121	592,217014	20345,359
10	Polygon	890	Urberg	jogi_10isv	4	121	302,331452	4523,0469
11	Polygon	890	Urberg	jogi_10isv	4	121	728,528216	25617,766
12	Polygon	890	Urberg	jogi_10isv	4	121	121,446075	241,82417
14	Polygon	890	Urberg	jogi_10isv	4	121	244,305069	3686,6094
15	Polygon	890	Urberg	jogi_10isv	4	121	598,559565	21853,266
16	Polygon	890	Urberg	jogi_10isv	4	121	683,951588	21384,609
17	Polygon	890	Urberg	jogi_10isv	4	121	704,454054	24451,28
18	Polygon	890	Urberg	jogi_10isv	4	121	256,903909	3154,2386
20	Polygon	890	Urberg	jogi_10isv	4	121	166,740559	1955,75
22	Polygon	890	Urberg	jogi_10isv	4	121	305,241783	5380,4688
23	Polygon	890	Urberg	jogi_10isv	4	121	206,937898	2753,5625

Rock	Granular Soil	Till	Cohesive Soil	Others	
897557,4259	105055,3649	475985,02	975534,7662	119681,19	3E+06
34,9%	**4,1%**	**18,5%**	**37,9%**	**4,6%**	100,0%

24	Polygon	890	Urberg	jogi_10isv	4	121	171,828156	2069,7188
25	Polygon	890	Urberg	jogi_10isv	4	121	213,387968	3309,7969
26	Polygon	890	Urberg	jogi_10isv	4	121	147,024202	1478,6719
27	Polygon	890	Urberg	jogi_10isv	4	121	161,093155	1909,0313
28	Polygon	890	Urberg	jogi_10isv	4	121	377,021751	8989,75
30	Polygon	890	Urberg	jogi_10isv	4	121	190,950862	1709,655
31	Polygon	890	Urberg	jogi_10isv	4	121	166,208848	572,09481
33	Polygon	890	Urberg	jogi_10isv	4	121	654,544206	16532,136
34	Polygon	890	Urberg	jogi_10isv	4	121	729,865939	17284,911
35	Polygon	890	Urberg	jogi_10isv	4	121	168,274146	1806,8307
36	Polygon	890	Urberg	jogi_10isv	4	121	170,594562	1559,0987
37	Polygon	890	Urberg	jogi_10isv	4	121	710,959358	16942,484
38	Polygon	890	Urberg	jogi_10isv	4	121	206,984895	2825,3191
39	Polygon	890	Urberg	jogi_10isv	4	121	184,84063	2162,4844
40	Polygon	890	Urberg	jogi_10isv	4	121	344,652942	5514,062
41	Polygon	890	Urberg	jogi_10isv	4	121	178,586507	2311,6875
43	Polygon	890	Urberg	jogi_10isv	4	121	857,385206	22400,691
44	Polygon	890	Urberg	jogi_10isv	4	121	412,834532	10634,781
46	Polygon	890	Urberg	jogi_10isv	4	121	167,461782	1852,0625
48	Polygon	890	Urberg	jogi_10isv	4	121	1310,75163	70325,015
50	Polygon	890	Urberg	jogi_10isv	4	121	478,806759	10219,199
51	Polygon	890	Urberg	jogi_10isv	4	121	421,169224	1942,9581
53	Polygon	890	Urberg	jogi_10isv	4	121	335,232771	5697,8125
54	Polygon	890	Urberg	jogi_10isv	4	121	32,461372	20,781788
56	Polygon	890	Urberg	jogi_10isv	4	121	267,782756	3788,7778
57	Polygon	890	Urberg	jogi_10isv	4	121	635,177892	23633,625
58	Polygon	890	Urberg	jogi_10isv	4	121	539,105159	9228,5092
59	Polygon	890	Urberg	jogi_10isv	4	121	352,822233	6218,1719
60	Polygon	890	Urberg	jogi_10isv	4	121	216,635866	3052,625
61	Polygon	890	Urberg	jogi_10isv	4	121	244,913406	3804,4721
62	Polygon	890	Urberg	jogi_10isv	4	121	238,388243	4233,2188
64	Polygon	890	Urberg	jogi_10isv	4	121	308,598909	5235,0625
65	Polygon	890	Urberg	jogi_10isv	4	121	224,170366	3428,0781
70	Polygon	890	Urberg	jogi_10isv	4	121	573,924987	22184,435
72	Polygon	890	Urberg	jogi_10isv	4	121	216,845368	2708,9375
73	Polygon	890	Urberg	jogi_10isv	4	121	757,065928	24591,835
74	Polygon	890	Urberg	jogi_10isv	4	121	257,306218	2114,6832
75	Polygon	890	Urberg	jogi_10isv	4	121	454,416147	8559,1875
76	Polygon	890	Urberg	jogi_10isv	4	121	251,314353	3471,6406
77	Polygon	890	Urberg	jogi_10isv	4	121	284,023054	3915,0313
78	Polygon	890	Urberg	jogi_10isv	4	121	236,677226	3269,2031
80	Polygon	890	Urberg	jogi_10isv	4	121	247,792873	3871,5018
81	Polygon	890	Urberg	jogi_10isv	4	121	45,798632	73,863377
82	Polygon	890	Urberg	jogi_10isv	4	121	140,70432	1053,7339
84	Polygon	890	Urberg	jogi_10isv	4	121	448,776594	12835,219
86	Polygon	890	Urberg	jogi_10isv	4	121	169,201309	2049,8594
89	Polygon	890	Urberg	jogi_10isv	4	121	514,463624	8031,4774
90	Polygon	890	Urberg	jogi_10isv	4	121	508,410518	13501,563
91	Polygon	890	Urberg	jogi_10isv	4	121	224,733624	3575,9531
92	Polygon	890	Urberg	jogi_10isv	4	121	251,596679	4655,6719
94	Polygon	890	Urberg	jogi_10isv	4	121	629,859646	21555,422
95	Polygon	890	Urberg	jogi_10isv	4	121	649,38474	10110,763
97	Polygon	890	Urberg	jogi_10isv	4	121	497,259418	11577,9
100	Polygon	890	Urberg	jogi_10isv	4	121	206,459091	2383,1406
101	Polygon	890	Urberg	jogi_10isv	4	121	1816,85852	97614,563
103	Polygon	890	Urberg	jogi_10isv	4	121	180,684559	2341,6406
104	Polygon	890	Urberg	jogi_10isv	4	121	233,499474	3420,7031
105	Polygon	890	Urberg	jogi_10isv	4	121	192,607474	1816,5926
108	Polygon	890	Urberg	jogi_10isv	4	121	292,809253	5196,9844
109	Polygon	890	Urberg	jogi_10isv	4	121	127,071601	736,16024
110	Polygon	890	Urberg	jogi_10isv	4	121	963,901571	50307,016
111	Polygon	890	Urberg	jogi_10isv	4	121	308,585114	5707,7969
113	Polygon	890	Urberg	jogi_10isv	4	121	1144,81191	60413,219
115	Polygon	890	Urberg	jogi_10isv	4	121	199,700076	2841,4375
117	Polygon	890	Urberg	jogi_10isv	4	121	492,454528	16483,234
118	Polygon	890	Urberg	jogi_10isv	4	121	201,358486	2702,5781
120	Polygon	890	Urberg	jogi_10isv	4	121	486,181629	12370,14
121	Polygon	890	Urberg	jogi_10isv	4	121	172,817257	2187,3906
122	Polygon	890	Urberg	jogi_10isv	4	121	262,913605	4798,9375
123	Polygon	890	Urberg	jogi_10isv	4	121	313,299992	3879,425
124	Polygon	890	Urberg	jogi_10isv	4	121	237,518879	3763,4219
								2573813,8

Vårby Gård (Res&Mix)

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTY	SYMBO	Shape_Lengt	Shape_Area
13	Polygon	40	Glacial lera	jogi_10isv	4	227	386,558082	3830,7044
28	Polygon	40	Glacial lera	jogi_10isv	4	227	2765,90923	35439,065
9	Polygon	55	Isälvssediment, sand	jogi_10isv	4	18	1288,80217	63928,088
1	Polygon	19	Postglacial finlera	jogi_10isv	4	221	476,676098	3650,3678
11	Polygon	28	Postglacial finsand	jogi_10isv	4	35	399,609968	6809,2647
24	Polygon	28	Postglacial finsand	jogi_10isv	4	35	639,360766	7261,2271
25	Polygon	31	Postglacial sand	jogi_10isv	4	9	1298,08629	29523,828
31	Polygon	31	Postglacial sand	jogi_10isv	4	9	790,8709	10754,64
10	Polygon	95	Sandig morän	jogi_10isv	4	229	34,498303	41,204593
14	Polygon	95	Sandig morän	jogi_10isv	4	229	303,735276	2470,1848
19	Polygon	95	Sandig morän	jogi_10isv	4	229	518,023656	3940,0608
21	Polygon	95	Sandig morän	jogi_10isv	4	229	133,99282	847,04221
22	Polygon	95	Sandig morän	jogi_10isv	4	229	254,61775	1450,1023
23	Polygon	95	Sandig morän	jogi_10isv	4	229	73,910847	137,01556
26	Polygon	95	Sandig morän	jogi_10isv	4	229	1236,74759	23587,016
27	Polygon	95	Sandig morän	jogi_10isv	4	229	987,171628	18937,926
32	Polygon	95	Sandig morän	jogi_10isv	4	229	512,046493	7659,5464
17	Polygon	9	Svämsediment, ler--silt	jogi_10isv	4	217	206,105023	1086,8869
2	Polygon	890	Urberg	jogi_10isv	4	121	90,52743	149,69749
3	Polygon	890	Urberg	jogi_10isv	4	121	212,060887	3277,0423
4	Polygon	890	Urberg	jogi_10isv	4	121	261,471106	4771,5938
5	Polygon	890	Urberg	jogi_10isv	4	121	418,220268	11457,435
6	Polygon	890	Urberg	jogi_10isv	4	121	286,093942	4390,5331
7	Polygon	890	Urberg	jogi_10isv	4	121	607,27311	15041,475
8	Polygon	890	Urberg	jogi_10isv	4	121	159,305602	1394,4747
12	Polygon	890	Urberg	jogi_10isv	4	121	249,197102	4225,107
15	Polygon	890	Urberg	jogi_10isv	4	121	38,486153	43,213871
16	Polygon	890	Urberg	jogi_10isv	4	121	378,096373	9073,0753
18	Polygon	890	Urberg	jogi_10isv	4	121	809,280942	18845,275
20	Polygon	890	Urberg	jogi_10isv	4	121	0,414189	0,006599
29	Polygon	890	Urberg	jogi_10isv	4	121	261,711983	1608,588
30	Polygon	890	Urberg	jogi_10isv	4	121	513,732606	8505,2579
								304136,95

Rock	Granular Soil	Till	Cohesive Soil	Others	
82782,77522	118277,0478	59070,099	44007,02452	0	304137
27,2%	**38,9%**	**19,4%**	**14,5%**	**0,0%**	100,0%

Masmo Vårby Haga

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYI	SYMBO	Shape_Lengt	Shape_Area
1	Polygon	55	Isälvssediment, sand	jogi_10isv	4	18	1133,76256	25401,953
2	Polygon	40	Glacial lera	jogi_10isv	4	227	1028,41645	36327,811
3	Polygon	890	Urberg	jogi_10isv	4	121	148,769302	1064,8336
								62794,598

Rock	Granular Soil	Till	Cohesive Soil	Others	
1064,833627	25401,95312	0	36327,81088	0	62795
1,7%	**40,5%**	**0,0%**	**57,9%**	**0,0%**	100,0%

Trångsund

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYI	SYMBO	Shape_Lengt	Shape_Area
28	Polygon	200	Fyllning	jogi_10i01	2	921	869,850895	8524,7954
3	Polygon	40	Glacial lera	jogi_10i01	2	227	10316,217	290935,02
7	Polygon	40	Glacial lera	jogi_10i01	2	227	708,189919	8030,4707
9	Polygon	40	Glacial lera	jogi_10i01	2	227	321,597943	1794,5445
15	Polygon	40	Glacial lera	jogi_10i01	2	227	428,460223	8282,2923
1	Polygon	16	Gyttjelera (eller lergyttja	jogi_10i01	2	4	339,459239	4653,403
4	Polygon	16	Gyttjelera (eller lergyttja	jogi_10i01	2	4	775,397958	20886,949
19	Polygon	16	Gyttjelera (eller lergyttja	jogi_10i01	2	4	194,130617	1244,3338
8	Polygon	5	Kärrtorv	jogi_10i01	2	2	506,7804	11277,881
6	Polygon	17	Postglacial lera	jogi_10i01	2	916	951,026091	23852,735
23	Polygon	17	Postglacial lera	jogi_10i01	2	916	794,256606	42854,668
26	Polygon	17	Postglacial lera	jogi_10i01	2	916	7,864575	1,370225
2	Polygon	890	Urberg	jogi_10i01	2	121	2711,22244	262592,13
5	Polygon	890	Urberg	jogi_10i01	2	121	80,204056	424,41276
10	Polygon	890	Urberg	jogi_10i01	2	121	62,83725	251,17975
11	Polygon	890	Urberg	jogi_10i01	2	121	157,140643	1398,3237
12	Polygon	890	Urberg	jogi_10i01	2	121	3,773964	0,595109
13	Polygon	890	Urberg	jogi_10i01	2	121	314,037895	5665,1744
14	Polygon	890	Urberg	jogi_10i01	2	121	230,865496	2071,1089
16	Polygon	890	Urberg	jogi_10i01	2	121	2016,60832	86473,806
17	Polygon	890	Urberg	jogi_10i01	2	121	196,459327	2349,0624
18	Polygon	890	Urberg	jogi_10i01	2	121	2580,80889	87815,465
20	Polygon	890	Urberg	jogi_10i01	2	121	562,529887	15298,913
21	Polygon	890	Urberg	jogi_10i01	2	121	221,67312	2955,804
22	Polygon	890	Urberg	jogi_10i01	2	121	1410,76113	84448,604
24	Polygon	890	Urberg	jogi_10i01	2	121	227,129364	1700,5396
25	Polygon	890	Urberg	jogi_10i01	2	121	1413,26528	74372,916
27	Polygon	890	Urberg	jogi_10i01	2	121	720,337522	15506,244
								1065662,7

Rock	Granular Soil	Till	Cohesive Soil	Others	
643324,2748	0	0	402535,783	19802,676	1E+06
60,4%	**0,0%**	**0,0%**	**37,8%**	**1,9%**	100,0%

Skogås

OBJECTID	Shape *	JG2	JG2_TX	KARTERIN	KARTTYI	SYMBO	Shape_Lengt	Shape_Area
15	Polygon	200	Fyllning	jogi_10i01	2	921	869,845925	8523,8017
1	Polygon	40	Glacial lera	jogi_10i01	2	227	4507,69064	129326,32
4	Polygon	40	Glacial lera	jogi_10i01	2	227	687,256145	8016,4819
17	Polygon	40	Glacial lera	jogi_10i01	2	227	8756,08484	166587,66
19	Polygon	40	Glacial lera	jogi_10i01	2	227	2454,20361	49647,417
2	Polygon	16	Gyttjelera (eller lergyttja	jogi_10i01	2	4	775,398434	20886,979
18	Polygon	16	Gyttjelera (eller lergyttja	jogi_10i01	2	4	821,348262	11940,374
32	Polygon	16	Gyttjelera (eller lergyttja	jogi_10i01	2	4	300,405423	6483,4783
5	Polygon	5	Kärrtorv	jogi_10i01	2	2	506,78163	11277,952
29	Polygon	1	Mossetorv	jogi_10i01	2	1	813,850194	29848,342
12	Polygon	17	Postglacial lera	jogi_10i01	2	916	773,470623	39950,889
13	Polygon	17	Postglacial lera	jogi_10i01	2	916	7,808823	1,35086
31	Polygon	17	Postglacial lera	jogi_10i01	2	916	1182,09062	11627,31
3	Polygon	890	Urberg	jogi_10i01	2	121	80,204056	424,41276
6	Polygon	890	Urberg	jogi_10i01	2	121	62,83725	251,17975
7	Polygon	890	Urberg	jogi_10i01	2	121	157,141026	1398,3317
8	Polygon	890	Urberg	jogi_10i01	2	121	3,774431	0,59527
9	Polygon	890	Urberg	jogi_10i01	2	121	2016,60864	86473,832
10	Polygon	890	Urberg	jogi_10i01	2	121	196,459327	2349,0624
11	Polygon	890	Urberg	jogi_10i01	2	121	1391,5786	81704,9
14	Polygon	890	Urberg	jogi_10i01	2	121	720,317625	15504,217
16	Polygon	890	Urberg	jogi_10i01	2	121	25,568851	26,189932
20	Polygon	890	Urberg	jogi_10i01	2	121	872,199576	30135,978
21	Polygon	890	Urberg	jogi_10i01	2	121	509,738184	15119,333
22	Polygon	890	Urberg	jogi_10i01	2	121	178,571716	1848,0386
23	Polygon	890	Urberg	jogi_10i01	2	121	108,666935	592,18611
24	Polygon	890	Urberg	jogi_10i01	2	121	163,274725	1876,2381
25	Polygon	890	Urberg	jogi_10i01	2	121	209,091008	2568,0522
26	Polygon	890	Urberg	jogi_10i01	2	121	422,022844	5836,1789
27	Polygon	890	Urberg	jogi_10i01	2	121	5172,24606	357838,07
28	Polygon	890	Urberg	jogi_10i01	2	121	2834,78402	48785,047
30	Polygon	890	Urberg	jogi_10i01	2	121	142,697939	1129,001
33	Polygon	890	Urberg	jogi_10i01	2	121	1541,68537	94305,389
34	Polygon	890	Urberg	jogi_10i01	2	121	269,005143	4348,454
35	Polygon	890	Urberg	jogi_10i01	2	121	1032,92029	29906,177
36	Polygon	890	Urberg	jogi_10i01	2	121	90,632503	422,99497
								1276962,2

Rock	Granular Soil	Till	Cohesive Soil	Others	
782843,8545	0	0	444468,2583	49650,095	1E+06
61,3%	**0,0%**	**0,0%**	**34,8%**	**3,9%**	100,0%

Appendix 4: ESAR Model Inputs and Outputs
(With Material Balance)

ESAR Model

Study Area: Södertörn; Botkyrka, Haninge, Huddinge

Study Time Horizon: 2016 to 2030

							ESAR Model Inputs																
							Residential		Non-Residential			Standard Input Variables							Geology				
Longitude	Latitude	Municipality	District(s)	Start	Completion	Type	Projected Population Increase	Avg. No. Of Floors	Gross Floor Area (Ind/Serv/Comm) (Low Rise Commercial)	Gross Floor Area (Offices/ Multistorey Commercial)	Avg. No. Of Floors (Offices)	Avg. Residential Building Area (m²)	Excavation Factor	Excavation Depth (m)	NFA/GFA	Living Area/ Person (m²)	No. of People per Household	Share of Underground Parking	%Rock	%Sands and Gravel	%Till	%Clayey/ Silty Soils	%Others (Artificial Fill/ Peat)
17,990895	59,230805	Huddinge	Storängen	2016	2030	Residential (Apt)	8289	5				700	1,4	4	0,8	38	1,85	0,5	6,1%	0,0%	0,0%	16,5%	77,4%
17,979351	59,237500	Huddinge	Huddinge Centrum	2016	2030	Residential (Apt)	6028	5				700	1,4	4	0,8	38	1,85	0,5	30,7%	0,0%	3,2%	47,4%	18,7%
18,153501	59,218617	Huddinge	Skogås	2016	2030	Residential (Apt)	2713	5				700	1,4	4	0,8	38	1,85	0,5	61,3%	0,0%	0,0%	34,8%	3,9%
18,130777	59,227840	Huddinge	Trångsund	2016	2030	Residential (Apt)	2713	6				700	1,4	4	0,8	38	1,85	0,5	60,4%	0,0%	0,0%	37,8%	1,9%
17,885881	59,264399	Huddinge	Vårby Gård	2016	2030	Residential (Apt)	1507	5				700	1,4	4	0,8	38	1,85	0,5	27,2%	38,9%	19,4%	14,5%	0,0%
17,995739	59,254619	Huddinge	Stuvsta	2016	2030	Residential (Apt)	754	3				700	1,4	4	0,8	38	1,85	0,5	19,2%	0,0%	3,2%	77,6%	0,0%
17,943897	59,279665	Huddinge	Segeltorp	2016	2030	Residential (Apt)	603	4				700	1,4	4	0,8	38	1,85	0,5	8,6%	0,0%	0,0%	19,2%	72,3%
17,879878	59,248530	Huddinge	Masmo Vårby Haga	2016	2030	Residential (Apt)	453	5				700	1,4	4	0,8	38	1,85	0,5	1,7%	40,5%	0,0%	57,9%	0,0%
17,938844	59,217928	Huddinge	Flemingsberg	2016	2030	Residential (Apt)	9782	4				700	1,4	4	0,8	38	1,85	0,5	40,0%	0,3%	19,9%	36,3%	3,4%
17,990895	59,230805	Huddinge	Storängen	2016	2030	Ind/Com/Ser (Low Rise)			18125										6,1%	0,0%	0,0%	16,5%	77,4%
17,979351	59,237500	Huddinge	Huddinge Centrum	2016	2030	Ind/Com/Ser (Low Rise)			11800										33,9%	0,0%	1,3%	63,1%	1,7%
17,938844	59,217928	Huddinge	Flemingsberg	2016	2030	Ind/Com/Ser (Low Rise)			16000										40,0%	0,3%	19,9%	36,3%	3,4%
17,912384	59,265882	Huddinge	Kungens Kurva	2016	2030	Ind/Com/Ser (Low Rise)			158000										34,9%	4,1%	18,5%	37,9%	4,6%
17,990895	59,230805	Huddinge	Storängen	2016	2030	Commercial (High Rise)				53875	5								6,1%	0,0%	0,0%	16,5%	77,4%
17,979351	59,237500	Huddinge	Huddinge Centrum	2016	2030	Commercial (High Rise)				20800	6								25,2%	0,0%	0,0%	47,2%	27,6%
17,938844	59,217928	Huddinge	Flemingsberg	2016	2030	Commercial (High Rise)				144000	5								40,0%	0,3%	19,9%	36,3%	3,4%
17,912384	59,265882	Huddinge	Kungens Kurva	2016	2030	Commercial (High Rise)				632000	4								34,9%	4,1%	18,5%	37,9%	4,6%
17,862143	59,250589	Botkyrka	Fittja	2016	2020	Residential (Apt)	1442	5				700	1,4	4	0,8	38	1,85	0,5	10,7%	17,5%	19,0%	52,7%	0,0%
17,854567	59,256902	Botkyrka	Slagsta Strand	2020	2024	Residential (Apt)	1442	4				700	1,4	4	0,8	38	1,85	0,5	20,3%	16,5%	6,7%	56,5%	0,0%
17,845380	59,249116	Botkyrka	Between Hallunda/Fittja	2020	2024	Residential (Apt)	1442	5				700	1,4	4	0,8	38	1,85	0,5	2,9%	0,3%	4,2%	92,6%	0,0%
17,833453	59,241564	Botkyrka	Eriksberg (A)	2020	2024	Residential (Apt)	1442	4				700	1,4	4	0,8	38	1,85	0,5	38,1%	1,2%	8,6%	51,9%	0,3%
17,823192	59,244332	Botkyrka	Hallunda	2024	2028	Residential (Apt)	1442	7				700	1,4	4	0,8	38	1,85	0,5	21,1%	1,8%	20,5%	56,6%	0,0%
17,840985	59,200461	Botkyrka	Tumba C	2016	2020	Residential (Apt)	1655	5				700	1,4	4	0,8	38	1,85	0,5	9,8%	1,8%	13,4%	75,0%	0,0%
17,840015	59,193709	Botkyrka	Storvreten	2020	2024	Residential (Apt)	1655	7				700	1,4	4	0,8	38	1,85	0,5	32,2%	11,9%	23,3%	32,6%	0,0%
17,828342	59,224037	Botkyrka	Stråket Kring E4/E20 (A)	2024	2032	Residential (Apt)	1655	5				700	1,4	4	0,8	38	1,85	0,5	19,0%	0,0%	5,7%	75,3%	0,0%
17,907478	59,206476	Botkyrka	Tullinge C (B)	2024	2028	Residential (Apt)	3977	6				700	1,4	4	0,8	38	1,85	0,5	15,9%	11,7%	2,7%	69,7%	0,0%
17,923233	59,187613	Botkyrka	Riksten Företagspark	2016	2020	Ind/Com/Ser (Low Rise)			26250										63,8%	0,4%	28,8%	5,1%	2,0%
17,857164	59,235995	Botkyrka	Alby	2016	2020	Ind/Com/Ser (Low Rise)			4000										7,1%	0,0%	5,7%	87,1%	0,0%
17,854567	59,256902	Botkyrka	Slagsta Strand	2020	2024	Ind/Com/Ser (Low Rise)			3000										20,3%	16,5%	6,7%	56,5%	0,0%
17,833453	59,241564	Botkyrka	Eriksberg (A)	2020	2024	Ind/Com/Ser (Low Rise)			1000										38,1%	1,2%	8,6%	51,9%	0,3%
17,829505	59,235955	Botkyrka	Eriksberg (B)	2020	2024	Ind/Com/Ser (Low Rise)			1000										9,2%	0,0%	6,4%	53,5%	31,0%
17,840015	59,193709	Botkyrka	Storvreten	2020	2024	Ind/Com/Ser (Low Rise)			12000										32,2%	11,9%	23,3%	32,6%	0,0%
17,845380	59,249116	Botkyrka	Between Hallunda/Fittja	2020	2024	Ind/Com/Ser (Low Rise)			2000										2,9%	0,3%	4,2%	92,6%	0,0%
17,907478	59,206476	Botkyrka	Tullinge C (B)	2024	2028	Ind/Com/Ser (Low Rise)			8500										15,9%	11,7%	2,7%	69,7%	0,0%
17,828342	59,224037	Botkyrka	Stråket Kring E4/E20 (A)	2024	2032	Ind/Com/Ser (Low Rise)			10000										19,0%	0,0%	5,7%	75,3%	0,0%
17,841400	59,214966	Botkyrka	Stråket Kring E4/E20 (B)	2024	2032	Ind/Com/Ser (Low Rise)			10000										53,0%	0,0%	18,2%	28,8%	0,0%
17,817196	59,178056	Botkyrka	Norra Kassmyra Grustag	2028	2032	Ind/Com/Ser (Low Rise)			36000										0,0%	99,3%	0,0%	0,1%	0,6%
17,824234	59,192345	Botkyrka	Dalvägen	2028	2032	Ind/Com/Ser (Low Rise)			36000										7,9%	34,1%	9,8%	48,2%	0,0%
17,923233	59,187613	Botkyrka	Riksten Företagspark	2016	2020	Commercial (High Rise)				8750	3								63,8%	0,4%	28,8%	5,1%	2,0%
17,862143	59,250589	Botkyrka	Fittja	2016	2020	Commercial (High Rise)				6000	5								10,7%	17,5%	19,0%	52,7%	0,0%
17,857164	59,235995	Botkyrka	Alby	2016	2020	Commercial (High Rise)				4000	3								7,1%	0,0%	5,7%	87,1%	0,0%
17,840985	59,200461	Botkyrka	Tumba C	2016	2020	Commercial (High Rise)				16000	4								9,8%	1,8%	13,4%	75,0%	0,0%
17,854567	59,256902	Botkyrka	Slagsta Strand	2020	2024	Commercial (High Rise)				3000	4								20,3%	16,5%	6,7%	56,5%	0,0%
17,833453	59,241564	Botkyrka	Eriksberg (A)	2020	2024	Commercial (High Rise)				3000	4								38,1%	1,2%	8,6%	51,9%	0,3%
17,829505	59,235955	Botkyrka	Eriksberg (B)	2020	2024	Commercial (High Rise)				3000	3								9,2%	0,0%	6,4%	53,5%	31,0%
17,840015	59,193709	Botkyrka	Storvreten	2020	2024	Commercial (High Rise)				36000	5								32,2%	11,9%	23,3%	32,6%	0,0%
17,845380	59,249116	Botkyrka	Between Hallunda/Fittja	2020	2024	Commercial (High Rise)				6000	5								2,9%	0,3%	4,2%	92,6%	0,0%
17,907478	59,206476	Botkyrka	Tullinge C (B)	2024	2028	Commercial (High Rise)				25500	5								15,9%	11,7%	2,7%	69,7%	0,0%
17,823192	59,244332	Botkyrka	Hallunda	2024	2028	Commercial (High Rise)				4000	7								21,1%	1,8%	20,5%	56,6%	0,0%
17,828342	59,224037	Botkyrka	Stråket Kring E4/E20 (A)	2024	2032	Commercial (High Rise)				30000	4								19,0%	0,0%	5,7%	75,3%	0,0%
17,841400	59,214966	Botkyrka	Stråket Kring E4/E20 (B)	2024	2032	Commercial (High Rise)				30000	4								53,0%	0,0%	18,2%	28,8%	0,0%
17,817196	59,178056	Botkyrka	Norra Kassmyra Grustag	2028	2032	Commercial (High Rise)				12000	3								0,0%	99,3%	0,0%	0,1%	0,6%
17,824234	59,192345	Botkyrka	Dalvägen	2028	2032	Commercial (High Rise)				12000	3								7,9%	34,1%	9,8%	48,2%	0,0%
18,135827	59,184646	Haninge	Vega	2016	2030	Residential (Apt)	4556	5				700	10,4	4	9,8	47	10,85	9,5	62,1%	3,5%	1,5%	31,9%	0,9%
18,134584	59,166395	Haninge	Handen	2016	2030	Residential (Apt)	749	4				700	11,4	4	10,8	48	11,85	10,5	11,9%	83,4%	0,0%	3,6%	1,1%
18,126000	59,141046	Haninge	Jordbro	2016	2030	Residential (Apt)	562	5				700	12,4	4	11,8	49	12,85	11,5	0,4%	99,6%	0,0%	0,0%	0,0%
18,044668	59,101692	Haninge	Tungelsta	2016	2030	Residential (Apt)	305	3				700	14,4	4	13,8	51	14,85	13,5	11,8%	6,2%	0,0%	82,0%	0,0%
18,212822	59,190928	Haninge	Vendelsö-Gudö	2016	2030	Residential (Apt)	146	4				700	15,4	4	14,8	52	15,85	14,5	50,0%	15,0%	2,5%	27,5%	5,0%
18,174005	59,171294	Haninge	Brandbergen	2016	2030	Residential (Apt)	281	5				700	18,4	4	17,8	55	18,85	17,5	2,5%	2,5%	0,0%	95,0%	0,0%
18,172173	59,150163	Haninge	Albyberg	2016	2030	Ind/Com/Ser (Low Rise)			200000										62,5%	20,0%	12,5%	0,0%	5,0%
18,160114	59,170601	Haninge	Brandbergens Företagsby	2016	2030	Ind/Com/Ser (Low Rise)			1700										90,0%	0,0%	0,0%	5,0%	5,0%
18,152346	59,188433	Haninge	Norrby Gärde	2016	2030	Ind/Com/Ser (Low Rise)			25000										1,2%	6,6%	0,0%	92,1%	0,0%
18,126000	59,141046	Haninge	Jordbro	2016	2030	Commercial (High Rise)				13000	5								0,4%	99,6%	0,0%	0,0%	0,0%
18,172173	59,150163	Haninge	Albyberg	2016	2030	Commercial (High Rise)				600000	4								62,5%	20,0%	12,5%	0,0%	5,0%
18,160114	59,170601	Haninge	Brandbergens Företagsby	2016	2030	Commercial (High Rise)				5100	4								90,0%	0,0%	0,0%	5,0%	5,0%
18,152346	59,188433	Haninge	Norrby Gärde	2016	2030	Commercial (High Rise)				75000	4								1,2%	6,6%	0,0%	92,1%	0,0%
			Cross-Connection Södertörn							**Cross-Connection Södertörn**					**Cross-Connection Södertörn**						**Cross-Connection Södertörn**		
17,890128	59,250872	Huddinge	Masmolänken	2020	2024	Road	Refer to Separate Earthworks Quantities Spreadsheet					Refer to Separate Earthworks Quantities Spreadsheet							Refer to Separate Earthworks Quantities Spreadsheet				
17,917422	59,232019	Huddinge	Masmolänken-Botkyrkaleden	2020	2024	Road																	
17,974371	59,217240	Huddinge	Haningeleden 1	2020	2024	Road																	
18,082818	59,166093	Huddinge-Haninge	Haningeleden 2-4	2020	2024	Road																	
17,983898	59,212360	Huddinge-Haninge	Cross-Connection Södertorn	2020	2024	Road																	

ESAR Model

Study Area: **Södertörn; Botkyrka, Haninge, Huddinge**

Study Time Horizon: **2016 to 2030**

							Excavated Materials			Required Materials			Material Balance	Material In (T)			Material Out (T)		
Longitude	Latitude	Municipality	District(s)	Start	Completion	Type	Excavated Loose Rock (T)	Excavated Loose Sands and Gravel (T)	Excavated Loose Clayey/ Silty Soils (T)	Loose Crushed Rock Required (T)	Loose Sands and Gravels Required (T)	Loose General Backfill Required (T)	%onsite reuse	Crushed Rock	Sands and Gravels	Total Aggregates (Crushed Rock, Sands and Gravel)	Rock	Sands and Gravels	Cohesive
17,990895	59,230805	Huddinge	Storängen	2016	2030	Residential (Apt)	96203,43	0,00	210124,86	150827,76	71063,08	154695,14	15%	136397,25	71063,08	207460,33	81772,92	0,00	44554,78
17,979351	59,237500	Huddinge	Huddinge Centrum	2016	2030	Residential (Apt)	357268,73	0,00	460138,99	109686,30	51679,12	112498,77	15%	56095,99	51679,12	107775,12	303678,42	0,00	339731,64
18,153501	59,218617	Huddinge	Skogås	2016	2030	Residential (Apt)	314279,80	0,00	145392,16	49366,11	23259,03	50631,91	15%	2224,14	23259,03	25483,18	267137,83	0,00	91200,86
18,130777	59,227840	Huddinge	Trångsund	2016	2030	Residential (Apt)	265367,86	0,00	135295,01	42329,95	19943,92	43415,33	15%	2524,77	19943,92	22468,69	225562,68	0,00	88827,62
17,885881	59,264399	Huddinge	Vårby Gård	2016	2030	Residential (Apt)	89427,57	75366,39	64512,26	27421,58	12919,78	28124,69	15%	14007,44	1614,82	15622,26	76013,43	64061,43	34410,42
17,995739	59,254619	Huddinge	Stuvsta	2016	2030	Residential (Apt)	44523,25	0,00	145422,39	21541,88	10149,54	22094,24	15%	14863,40	10149,54	25012,94	37844,76	0,00	121774,95
17,943897	59,279665	Huddinge	Segeltorp	2016	2030	Residential (Apt)	11829,75	0,00	21628,49	13318,09	6274,87	13659,58	15%	11543,63	6274,87	17818,50	10055,29	0,00	7008,66
17,879878	59,248530	Huddinge	Masmo Vårby Haga	2016	2030	Residential (Apt)	1451,53	23565,47	40350,01	8242,85	3883,65	8454,20	15%	8025,12	348,83	8373,95	1233,80	20030,65	31301,48
17,938844	59,217928	Huddinge	Flemingsberg	2016	2030	Residential (Apt)	994212,35	5313,66	913206,44	216049,02	101792,33	221588,74	15%	66917,17	100995,28	167912,44	845080,49	4516,61	676040,20
17,990895	59,230805	Huddinge	Storängen	2016	2030	Ind/Com/Ser (Low Rise)	9017,41	0,00	19695,58	14137,50	6660,94	14500,00	15%	12784,89	6660,94	19445,83	7664,80	0,00	4176,24
17,979351	59,237500	Huddinge	Huddinge Centrum	2016	2030	Ind/Com/Ser (Low Rise)	32652,85	0,00	49828,23	9204,00	4336,50	9440,00	15%	4306,07	4336,50	8642,57	27754,92	0,00	39724,60
17,938844	59,217928	Huddinge	Flemingsberg	2016	2030	Ind/Com/Ser (Low Rise)	57430,35	306,94	52751,07	12480,00	5880,00	12800,00	15%	3865,45	5833,96	9699,41	48815,79	260,90	39051,24
17,912384	59,265882	Huddinge	Kungens Kurva	2016	2030	Ind/Com/Ser (Low Rise)	497302,84	35550,59	527643,44	123240,00	58065,00	126400,00	15%	48644,57	52732,41	101376,99	422707,41	30218,00	392357,62
17,990895	59,230805	Huddinge	Storängen	2016	2030	Commercial (High Rise)	5360,70	0,00	11708,68	8404,50	3959,81	8620,00	15%	7600,40	3959,81	11560,21	4556,59	0,00	2482,70
17,979351	59,237500	Huddinge	Huddinge Centrum	2016	2030	Commercial (High Rise)	7081,52	0,00	10791,35	2704,00	1274,00	2773,33	15%	1641,77	1274,00	2915,77	6019,29	0,00	7823,05
17,938844	59,217928	Huddinge	Flemingsberg	2016	2030	Commercial (High Rise)	103374,62	552,50	94951,92	22464,00	10584,00	23040,00	15%	6957,81	10501,13	17458,93	87868,43	469,62	70292,23
17,912384	59,265882	Huddinge	Kungens Kurva	2016	2030	Commercial (High Rise)	497302,84	35550,59	527643,44	123240,00	58065,00	126400,00	15%	48644,57	52732,41	101376,99	422707,41	30218,00	392357,62
17,862143	59,250589	Botkyrka	Fittja	2016	2020	Residential (Apt)	40335,45	32525,64	146072,98	26238,83	12362,52	26911,62	15%	20188,51	7483,68	27672,19	34285,13	27646,79	117269,50
17,854567	59,256902	Botkyrka	Slagsta Strand	2020	2024	Residential (Apt)	72019,82	37225,12	164475,57	31848,57	15005,58	32665,20	15%	21045,59	9421,81	30467,40	61216,85	31641,36	129514,04
17,845380	59,249116	Botkyrka	Between Hallunda/Fittja	2020	2024	Residential (Apt)	10262,23	552,49	212084,05	26238,83	12362,52	26911,62	15%	24699,49	12279,65	36979,14	8722,89	469,61	183280,57
17,833453	59,241564	Botkyrka	Eriksberg (A)	2020	2024	Residential (Apt)	132005,12	2652,58	155633,05	31848,57	15005,58	32665,20	15%	12047,80	14607,69	26655,49	112204,35	2254,69	120671,52
17,823192	59,244332	Botkyrka	Hallunda	2024	2028	Residential (Apt)	52487,39	2539,20	118602,44	19827,69	9341,89	20336,10	15%	11954,59	8961,02	20915,60	44614,28	2158,32	96836,73
17,840985	59,200461	Botkyrka	Tumba C	2016	2020	Residential (Apt)	39761,64	3929,45	214375,52	30114,60	14188,61	30886,77	15%	24150,36	13599,19	37749,55	33797,39	3340,03	181317,43
17,840015	59,193709	Botkyrka	Storvreten	2020	2024	Residential (Apt)	88076,11	19071,82	93551,61	22756,47	10721,80	23339,97	15%	9545,06	7861,03	17406,08	74864,70	16211,04	68570,85
17,828342	59,224037	Botkyrka	Stråket Kring E4/E20 (A)	2024	2032	Residential (Apt)	63196,15	0,00	201909,06	30114,60	14188,61	30886,77	15%	20635,18	14188,61	34823,79	53716,72	0,00	168850,97
17,907478	59,206476	Botkyrka	Tullinge C (B)	2024	2028	Residential (Apt)	106086,76	51332,86	375765,56	62051,68	29235,89	63642,75	15%	46138,67	21535,96	67674,62	90173,74	43632,93	307648,77
17,923233	59,187613	Botkyrka	Riksten Företagspark	2016	2020	Ind/Com/Ser (Low Rise)	148757,49	521,77	43042,97	20475,00	9646,88	21000,00	15%	0,00	9568,61	9568,61	128282,49	443,50	20566,69
17,857164	59,235995	Botkyrka	Alby	2016	2020	Ind/Com/Ser (Low Rise)	2716,30	0,00	24038,23	3120,00	1470,00	3200,00	15%	2712,56	1470,00	4182,56	2308,85	0,00	20613,28
17,854567	59,256902	Botkyrka	Slagsta Strand	2020	2024	Ind/Com/Ser (Low Rise)	5291,49	2735,03	12084,46	2340,00	1102,50	2400,00	15%	1546,28	692,25	2238,52	4497,77	2324,78	9515,75
17,833453	59,241564	Botkyrka	Eriksberg (A)	2020	2024	Ind/Com/Ser (Low Rise)	3232,92	64,96	3811,59	780,00	367,50	800,00	15%	295,06	357,76	652,82	2747,99	55,22	2955,35
17,829505	59,235955	Botkyrka	Eriksberg (B)	2020	2024	Ind/Com/Ser (Low Rise)	853,48	0,00	3818,24	780,00	367,50	800,00	15%	651,98	367,50	1019,48	725,46	0,00	2962,00
17,840015	59,193709	Botkyrka	Storvreten	2020	2024	Ind/Com/Ser (Low Rise)	36226,72	7844,46	38478,86	9360,00	4410,00	9600,00	15%	3925,99	3233,33	7159,32	30792,71	6667,79	28203,98
17,845380	59,249116	Botkyrka	Between Hallunda/Fittja	2020	2024	Ind/Com/Ser (Low Rise)	610,13	32,85	12609,22	1560,00	735,00	1600,00	15%	1468,48	730,07	2198,55	518,61	27,92	10896,74
17,907478	59,206476	Botkyrka	Tullinge C (B)	2024	2028	Ind/Com/Ser (Low Rise)	11334,99	5484,73	40149,21	6630,00	3123,75	6800,00	15%	4929,75	2301,04	7230,79	9634,74	4662,02	32871,17
17,828342	59,224037	Botkyrka	Stråket Kring E4/E20 (A)	2024	2032	Ind/Com/Ser (Low Rise)	16368,47	0,00	52296,58	7800,00	3675,00	8000,00	15%	5344,73	3675,00	9019,73	13913,20	0,00	43734,18
17,841400	59,214966	Botkyrka	Stråket Kring E4/E20 (B)	2024	2032	Ind/Com/Ser (Low Rise)	46094,31	0,00	27263,10	7800,00	3675,00	8000,00	15%	885,85	3675,00	4560,85	39180,17	0,00	18700,70
17,817196	59,178056	Botkyrka	Norra Kassmyra Grustag	2028	2032	Ind/Com/Ser (Low Rise)	0,00	197044,47	264,07	28080,00	13230,00	28800,00	15%	28080,00	0,00	28080,00	0,00	26546,00	0,00
17,824234	59,192345	Botkyrka	Dalvägen	2028	2032	Ind/Com/Ser (Low Rise)	29207,47	67693,44	130467,27	28080,00	13230,00	28800,00	15%	23698,88	3075,98	26774,86	24826,35	57539,43	99642,65
17,923233	59,187613	Botkyrka	Riksten Företagspark	2016	2020	Commercial (High Rise)	16528,61	57,97	4782,55	2275,00	1071,88	2333,33	15%	0,00	1063,18	1063,18	14253,61	49,28	2285,19
17,862143	59,250589	Botkyrka	Fittja	2016	2020	Commercial (High Rise)	1438,86	1160,27	5210,76	936,00	441,00	960,00	15%	720,17	266,96	987,13	1223,03	986,23	4183,28
17,857164	59,235995	Botkyrka	Alby	2016	2020	Commercial (High Rise)	905,43	0,00	8012,74	1040,00	490,00	1066,67	15%	904,19	490,00	1394,19	769,62	0,00	6871,09
17,840985	59,200461	Botkyrka	Tumba C	2016	2020	Commercial (High Rise)	4119,47	407,11	22210,21	3120,00	1470,00	3200,00	15%	2502,08	1408,93	3911,01	3501,55	346,04	18785,25
17,854567	59,256902	Botkyrka	Slagsta Strand	2020	2024	Commercial (High Rise)	1322,87	683,76	3021,12	585,00	275,63	600,00	15%	386,57	173,06	559,63	1124,44	581,19	2378,94
17,833453	59,241564	Botkyrka	Eriksberg (A)	2020	2024	Commercial (High Rise)	2424,69	48,72	2858,69	585,00	275,63	600,00	15%	221,30	268,32	489,61	2060,99	41,41	2216,52
17,829505	59,235955	Botkyrka	Eriksberg (B)	2020	2024	Commercial (High Rise)	853,48	0,00	3818,24	780,00	367,50	800,00	15%	651,98	367,50	1019,48	725,46	0,00	2962,00
17,840015	59,193709	Botkyrka	Storvreten	2020	2024	Commercial (High Rise)	21736,03	4706,68	23087,31	5616,00	2646,00	5760,00	15%	2355,60	1940,00	4295,59	18475,63	4000,67	16922,39
17,845380	59,249116	Botkyrka	Between Hallunda/Fittja	2020	2024	Commercial (High Rise)	366,08	19,71	7565,53	936,00	441,00	960,00	15%	881,09	438,04	1319,13	311,17	16,75	6538,04
17,907478	59,206476	Botkyrka	Tullinge C (B)	2024	2028	Commercial (High Rise)	6800,99	3290,84	24089,52	3978,00	1874,25	4080,00	15%	2957,85	1380,62	4338,47	5780,85	2797,21	19722,70
17,823192	59,244332	Botkyrka	Hallunda	2024	2028	Commercial (High Rise)	1179,88	57,08	2666,11	445,71	210,00	457,14	15%	268,73	201,44	470,17	1002,90	48,52	2176,83
17,828342	59,224037	Botkyrka	Stråket Kring E4/E20 (A)	2024	2032	Commercial (High Rise)	12276,35	0,00	39222,43	5850,00	2756,25	6000,00	15%	4008,55	2756,25	6764,80	10434,90	0,00	32800,64
17,841400	59,214966	Botkyrka	Stråket Kring E4/E20 (B)	2024	2032	Commercial (High Rise)	34570,73	0,00	20447,32	5850,00	2756,25	6000,00	15%	664,39	2756,25	3420,64	29385,12	0,00	14025,53
17,817196	59,178056	Botkyrka	Norra Kassmyra Grustag	2028	2032	Commercial (High Rise)	0,00	21893,83	29,34	3120,00	1470,00	3200,00	15%	3120,00	0,00	3120,00	0,00	2949,56	0,00
17,824234	59,192345	Botkyrka	Dalvägen	2028	2032	Commercial (High Rise)	3245,27	7521,49	14496,36	3120,00	1470,00	3200,00	15%	2633,21	341,78	2974,98	2758,48	6393,27	11071,41
18,135827	59,184646	Haninge	Vega	2016	2030	Residential (Apt)	564128,07	21386,57	242575,01	86955,67	40969,50	89185,30	15%	2336,46	37761,51	40097,97	479508,86	18178,59	147120,05
18,134584	59,166395	Haninge	Handen	2016	2030	Residential (Apt)	20450,04	97165,27	5038,91	16489,08	7768,89	16911,88	15%	13421,58	0,00	13421,58	17382,54	11346,01	0,00
18,126000	59,141046	Haninge	Jordbro	2016	2030	Residential (Apt)	412,46	77515,75	0,00	11007,93	5186,43	11290,19	15%	10946,06	0,00	10946,06	350,59	10496,50	0,00
18,044668	59,101692	Haninge	Tungelsta	2016	2030	Residential (Apt)	10332,61	3675,59	58245,57	8398,64	3957,05	8613,99	15%	6848,75	3405,72	10254,47	8782,72	3124,25	49026,02
18,212822	59,190928	Haninge	Vendelsö-Gudö	2016	2030	Residential (Apt)	17736,68	3582,64	8354,74	3379,54	1592,28	3466,19	15%	719,04	1054,89	1773,93	15076,18	3045,24	4644,87
18,174005	59,171294	Haninge	Brandbergen	2016	2030	Residential (Apt)	1531,25	1042,10	47411,95	5898,14	2778,93	6049,37	15%	5668,45	2622,62	8291,07	1301,56	885,78	40937,32
18,172173	59,150163	Haninge	Albyberg	2016	2030	Ind/Com/Ser (Low Rise)	1056137,32	220500,00	113278,85	156000,00	73500,00	160000,00	15%	0,00	40425,00	40425,00	900137,32	50354,00	0,00
18,160114	59,170601	Haninge	Brandbergens Företagsby	2016	2030	Ind/Com/Ser (Low Rise)	12393,00	0,00	561,00	1326,00	624,75	1360,00	15%	0,00	624,75	624,75	10262,88	0,00	0,00
18,152346	59,188433	Haninge	Norrby Gärde	2016	2030	Ind/Com/Ser (Low Rise)	2505,81	9151,86	152000,91	19500,00	9187,50	20000,00	15%	19124,13	7814,72	26938,85	2129,93	7779,08	130594,92
18,126000	59,141046	Haninge	Jordbro	2016	2030	Commercial (High Rise)	75,99	14280,79	0,00	2028,00	955,50	2080,00	15%	2016,60	0,00	2016,60	64,59	1933,78	0,00
18,172173	59,150163	Haninge	Albyberg	2016	2030	Commercial (High Rise)	792102,99	165375,00	84959,13	117000,00	55125,00	120000,00	15%	0,00	30318,75	30318,75	675102,99	37765,50	0,00
18,160114	59,170601	Haninge	Brandbergens Företagsby	2016	2030	Commercial (High Rise)	9294,75	0,00	420,75	994,50	468,56	1020,00	15%	0,00	468,56	468,56	7697,16	0,00	0,00
18,152346	59,188433	Haninge	Norrby Gärde	2016	2030	Commercial (High Rise)	1879,35	6863,89	114000,68	14625,00	6890,63	15000,00	15%	14343,10	5861,04	20204,14	1597,45	5834,31	97946,19
			Cross-Connection Södertörn				**Cross-Connection Södertörn**			**Cross-Connection Södertörn**				**Cross-Connection Södertörn**					
17,890128	59,250872	Huddinge	Masmolänken	2020	2024	Road	368838,69	130451,38	9152,00	96307,19	6522,00	0,00	50%	0,00	0,00	0,00	88112,16	59162,18	9152,00
17,917422	59,232019	Huddinge	Masmolänken-Botkyrkaleden	2020	2024	Road	0,00	0,00	84122,50	108014,69	189658,80	0,00	50%	186305,24	165080,44	351385,68	0,00	0,00	137384,50
17,974371	59,217240	Huddinge	Haningeleden 1	2020	2024	Road	117732,42	46749,68	60915,80	142115,51	265357,80	0,00	50%	71057,76	223328,52	294386,28	0,00	0,00	60915,80
18,082818	59,166093	Huddinge-Haninge	Haningeleden 2-4	2020	2024	Road	9459,43	14992,12	43400,41	147486,29	44019,92	0,00	50%	142756,57	33429,29	176185,86	0,00	0,00	43400,41
17,983898	59,212360	Huddinge-Haninge	Cross-Connection Södertorn	2020	2024	Road	496030,54	192193,18	197590,71	493923,68	505558,52	0,00	50%	312007,41	362676,07	674683,48	0,00	0,00	250852,71

Notes

General

Model focusses on earthworks arising from residential development and Low-rise (Industrial, commercial, municipal services) and multistorey commercial (offices)

Average Population Projections have been used

Data from Cross "Connection Södertörn imported from Soil and Rock Quantities (Road) spreadsheet

Split of Till

% of Rock | 30%

(Remainder classified as Cohesive Soil)

Material Balancing

For development projects, general back fill can be completely offset by site won material. The priority order of use is 1. Cohesive soils, 2. Granular Soils (Sands and Gravels), 3. Rock

For development projects, rock and sands and gravels required have been grouped into total Granular Soil required.

For road projects, till is assumed to be reused as embankment fill. In the special case of Cross-connection Södertorn, till encountered is very limited and has been split into 50% rock and 50% cohesive

For road projects, S&G required is equivalent to General Embankment Fill required. General Embankment Fill required is offset with S&G excavated followed by rock in that priority order.

Volumes

Excavated Loose Materials obtained by multiplying excavated volume by Bulking Factors (Bulking Factors tab)

Excavated Loose Material Weights obtained by multiplying loose volume by loose bulk densities

Loose Material Required obtained by multiplying compacted material volume by a Shrinkage Factor. Loose Material Volume = (Compacted Density/Bulk Loose Density) x Compacted Volume

Delimitations

Green areas in Municipal Plans not included. Assumed to not involve extensive earthworks or material needs

New and upgraded local roads have not been included. Major Cross-Connection Södertorn Road has been examined separately

Near surface geology considered only. Depth to bedrock not considered due to limitation of time

Topsoil thickness not considered in model

Due to limited information, only significant commercial areas have been input from Huddinge and Haninge.

Considerations

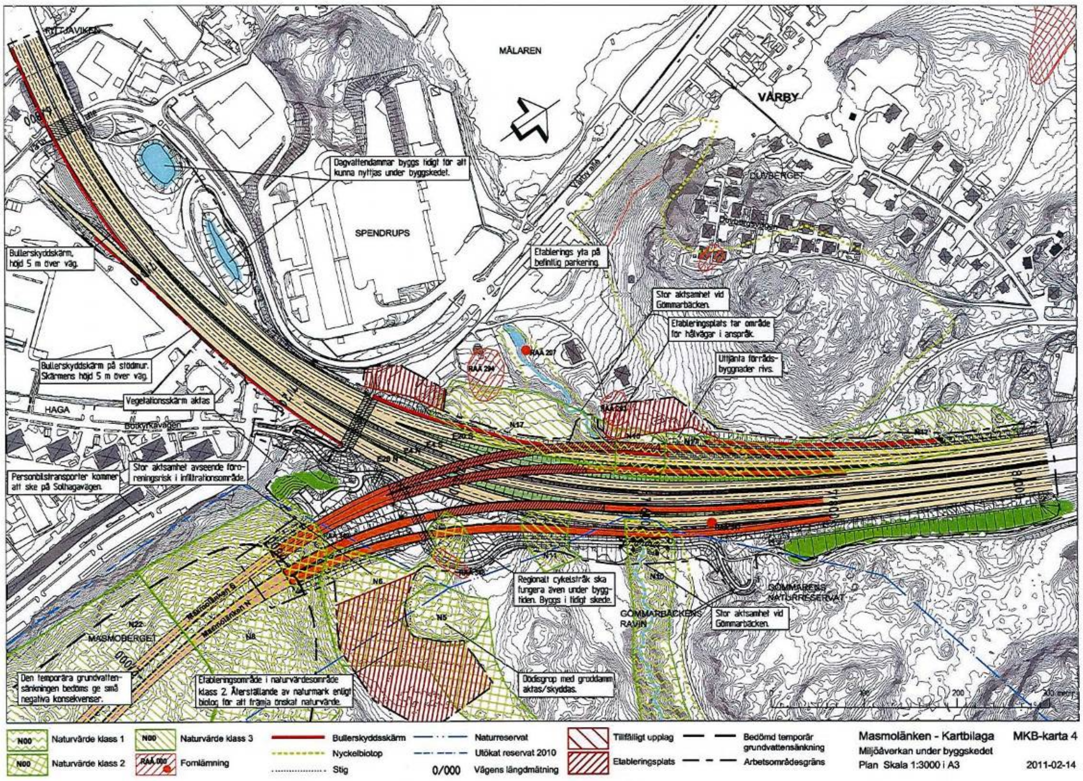
LRC foundations may be terminated at more shallow depths depending on soil bearing capacity/shallow depth to bedrock. Verification of the model assumptions should be made for commercial developments. In

Infrastructure included within residential calculations. Major infrastructure construction beyond residential areas should be considered separately.

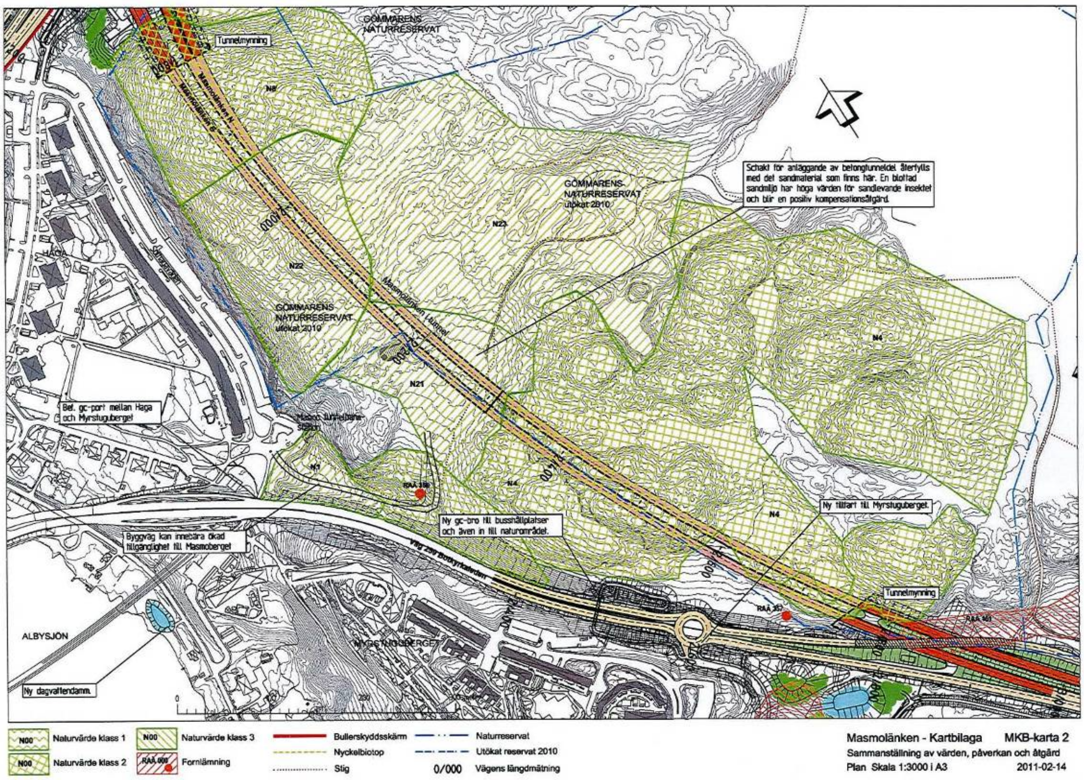
The Municipal plans detail projected job numbers. Consideration of developing a conversion factor for job numbers to GFA may assist in obtaining estimates for commercial GFA.

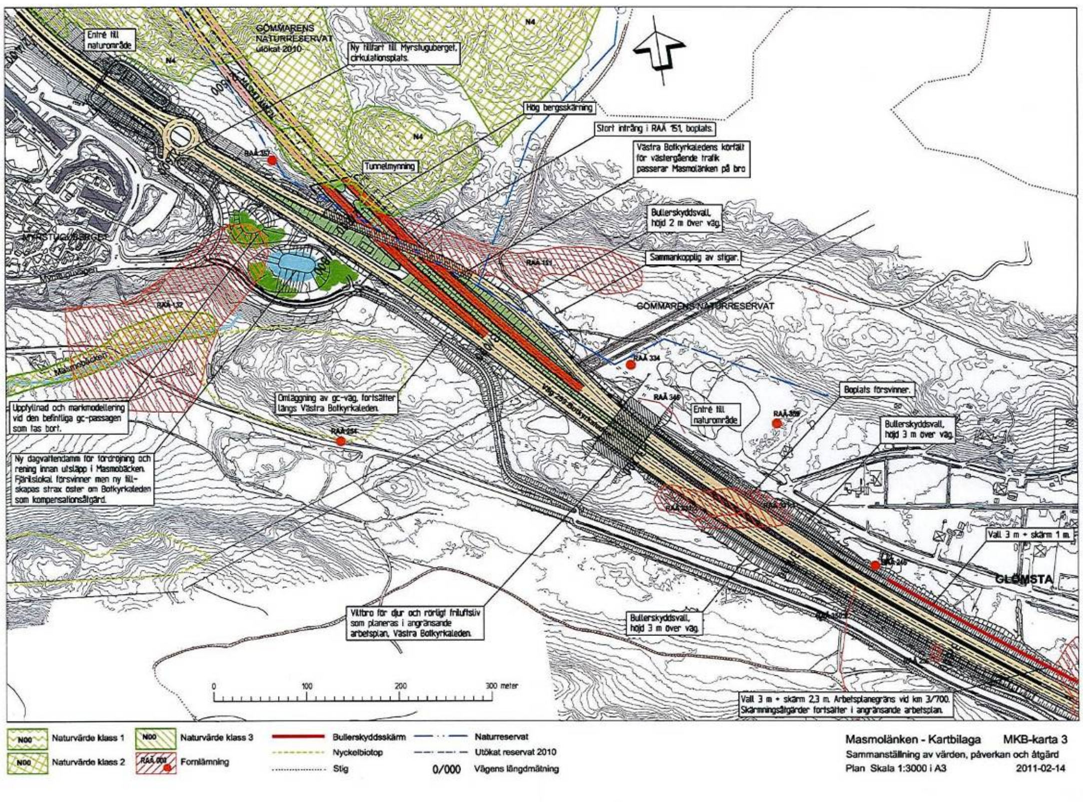
Consideration of the geology in or near the surface may be considered conservative with regards to quantities of rock. However, where the depth to bedrock may be more shallow, the excavation depth (particularly for roads and shallow foundations) may be reduced resulting in a reduction in the overall amount of material outflow from a development area. The model simplification for excavation depths can be fine tuned for development areas depending on the geology encountered. Due to a limitation of time, standard depth values have been used. With further consideration of site specific

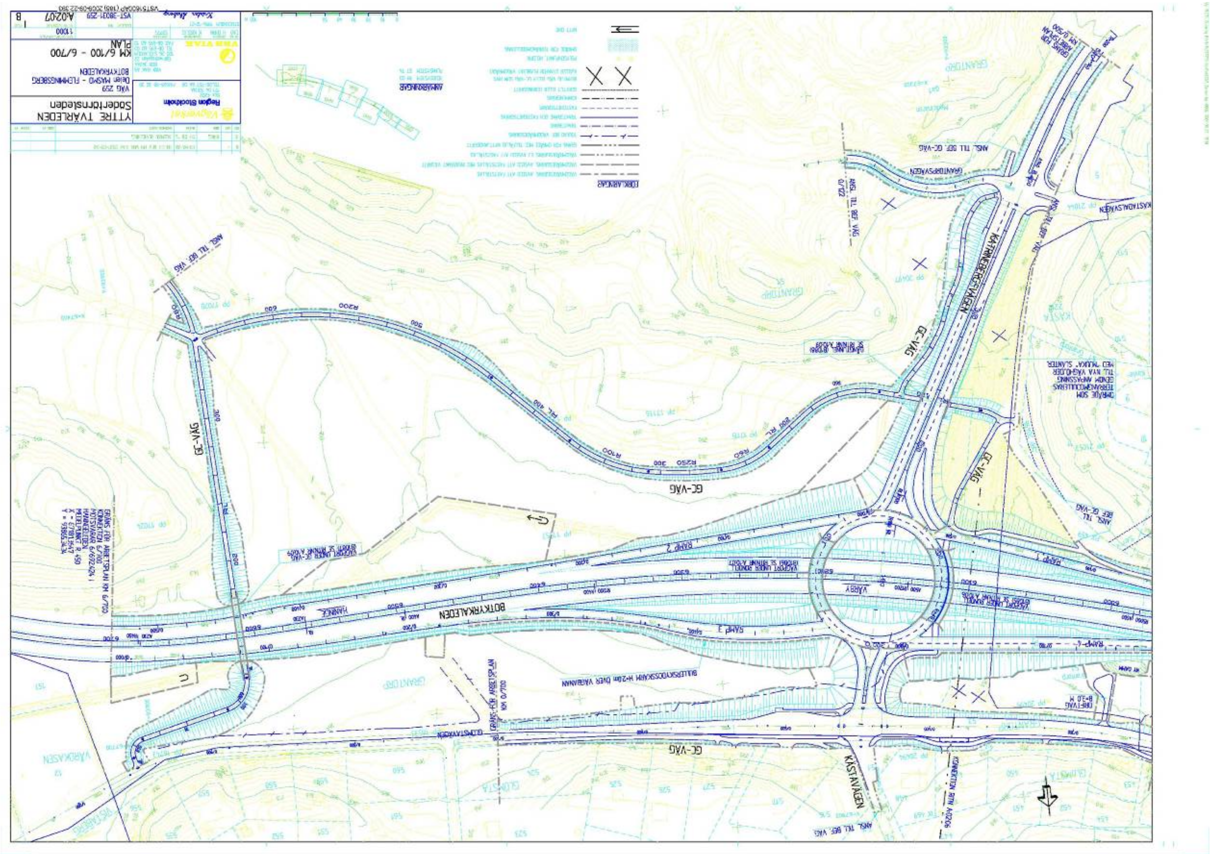
Appendix 5: Plans for Södertörnsleden
(Used for Cross-Connection Södertörn)

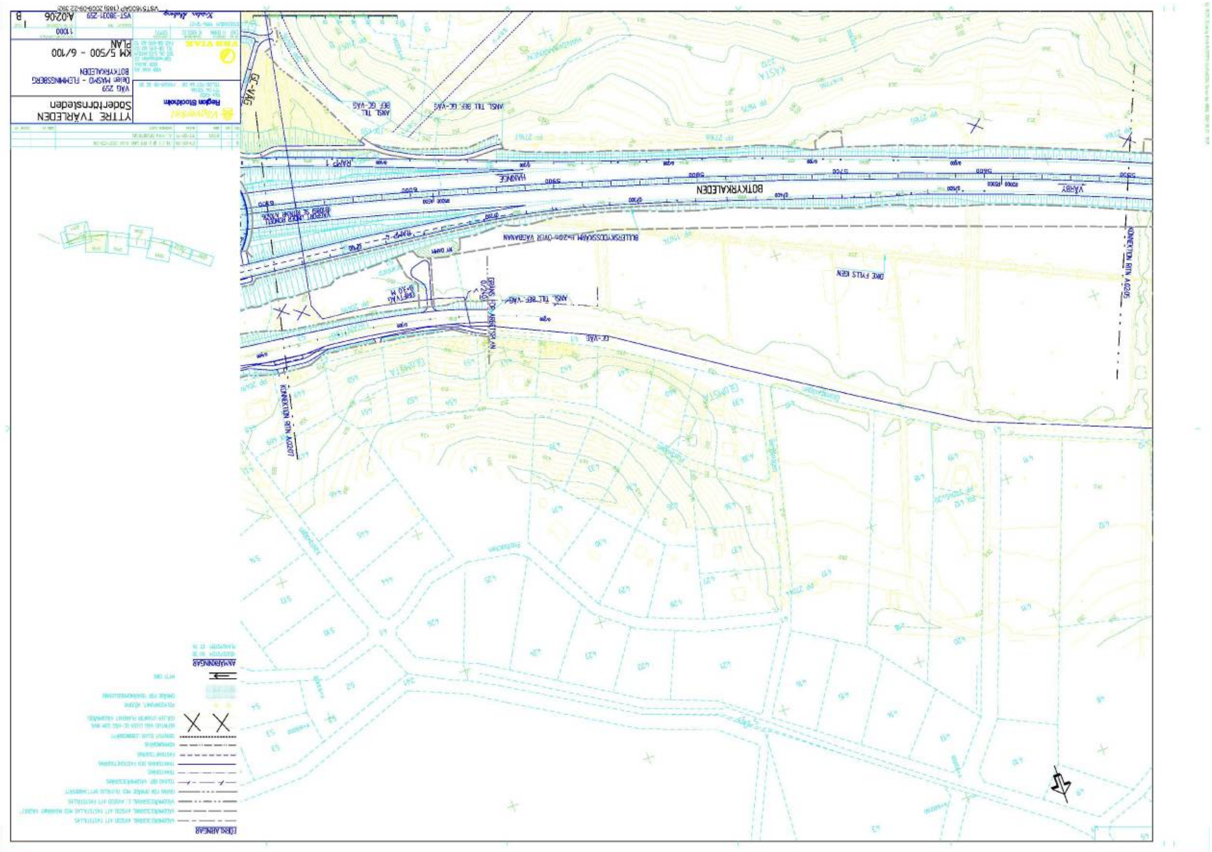

MÄLAREN
VÅRBY
SPENDRUPS
HAGA
MASMOBERGET
GÖMMARBÄCKENS RAVIN
GÖMMARENS NATURRESERVAT
Dagvattendammar byggs tidigt för att kunna nyttjas under byggskedet.
Bullerskyddskärm, höjd 5 m över väg.
Etablerings yta på befintlig parkering.
Stor aktsamhet vid Gömmarbäcken.
Etableringsplats för område för hjälvägar i anspråk.
Uttjänta förrådsbyggnader rivs.
Bullerskyddskärm på stödmur. Skärmens höjd 5 m över väg.
Vegetationsskärm aktas
Stor aktsamhet avseende föroreningsrisk i infiltrationsområde.
Personbilstransporter kommer att ske på Solhagavägen.
Regionalt cykelstråk ska fungera även under byggtiden. Byggs i tidigt skede.
Stor aktsamhet vid Gömmarbäcken.
Den temporära grundvattensänkningen bedöms ge små negativa konsekvenser.
Etableringsområde i naturvärdesområde klass 2. Återställande av naturmark enligt biolog för att främja önskat naturvärde.
Dödisgrop med groddamm aktas/skyddas.
RAÄ 207
RAÄ 284
N5
N8
N10
N17
N22
Naturvärde klass 1
Naturvärde klass 2
Naturvärde klass 3
Fornlämning
Bullerskyddsskärm
Nyckelbiotop
Stig
Naturreservat
Utökat reservat 2010
0/000 Vägens längdmätning
Tillfälligt upplag
Etableringsplats
Bedömd temporär grundvattensänkning
Arbetsområdesgräns
Masmolänken - Kartbilaga MKB-karta 4
Miljöåverkan under byggskedet
Plan Skala 1:3000 i A3
2011-02-14

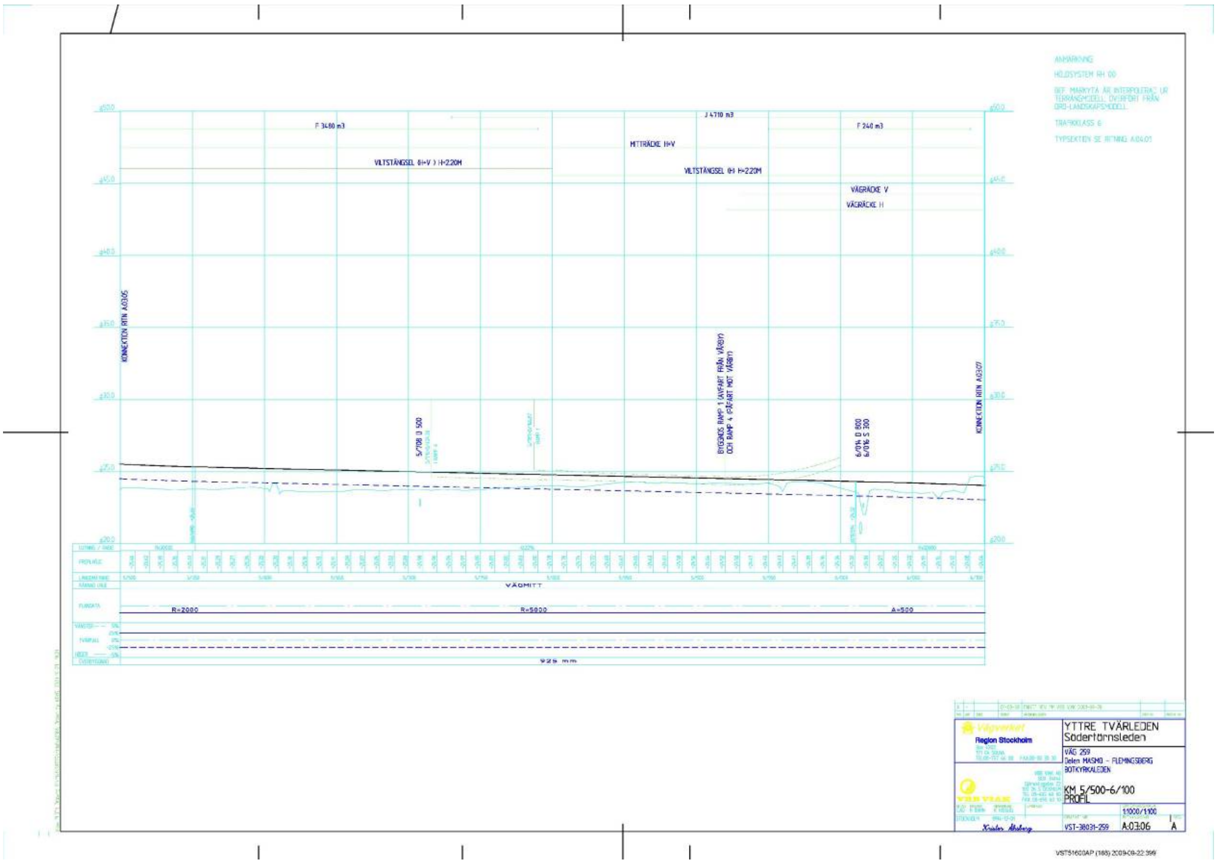
A5-2

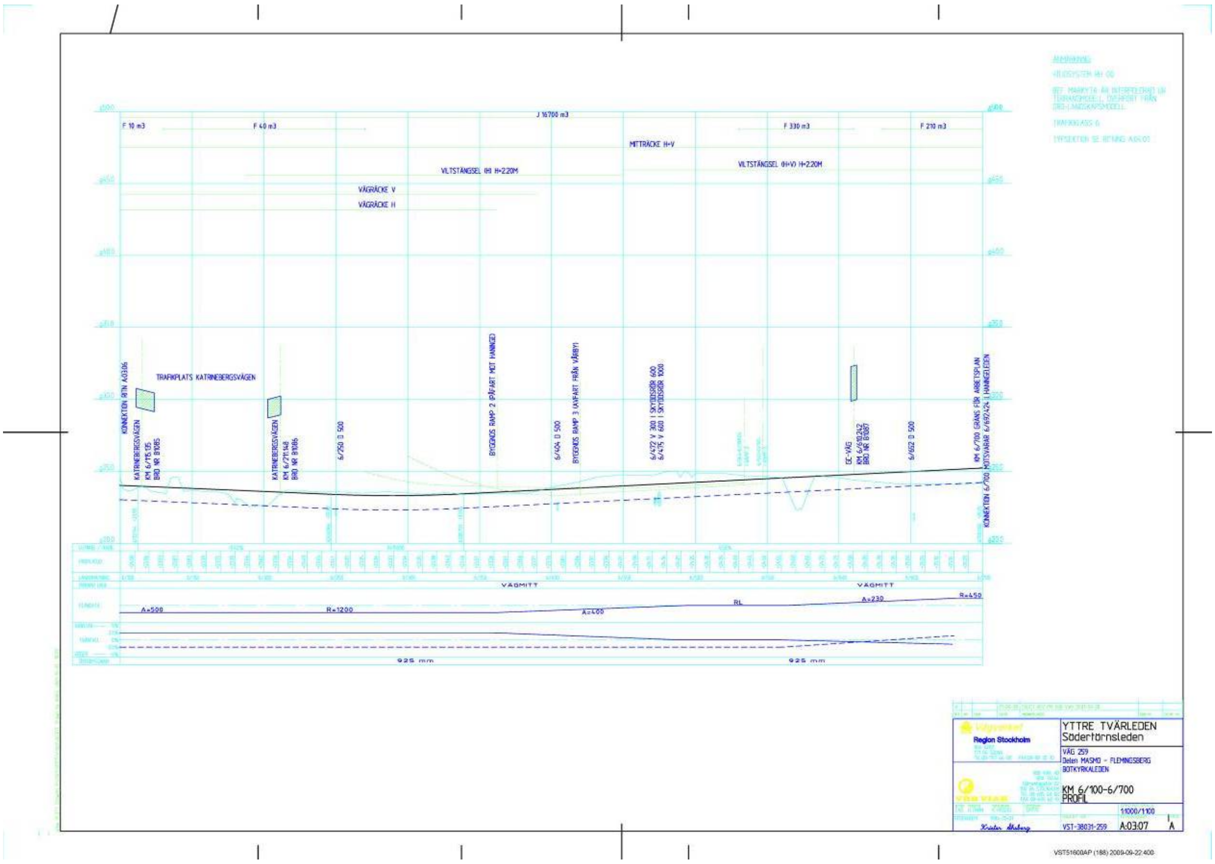

GÖMMARENS NATURRESERVAT
Tunnelmynning
GÖMMARENS NATURRESERVAT utökat 2010
Schakt för anläggande av betongtunneldel återfylls med det sandmaterial som finns här. En blottad sandmiljö har höga värden för sandlevande insekter och blir en positiv kompensationsåtgärd.
N4
N8
N21
N22
N23
N1
Bef. gc-port mellan Haga och Myrstuguberget
RAÄ 188
Ny gc-bro till busshållplatser och även in till naturområdet.
Byggväg kan innebära ökad tillgänglighet till Masmoberget
Ny tillfart till Myrstuguberget.
Tunnelmynning
ALBYSJÖN
Ny dagvattendamm.
Naturvärde klass 1
Naturvärde klass 2
Naturvärde klass 3
Fornlämning
Bullerskyddsskärm
Nyckelbiotop
Stig
Naturreservat
Utökat reservat 2010
0/000 Vägens längdmätning
Masmolänken - Kartbilaga MKB-karta 2
Sammanställning av värden, påverkan och åtgärd
Plan Skala 1:3000 i A3
2011-02-14

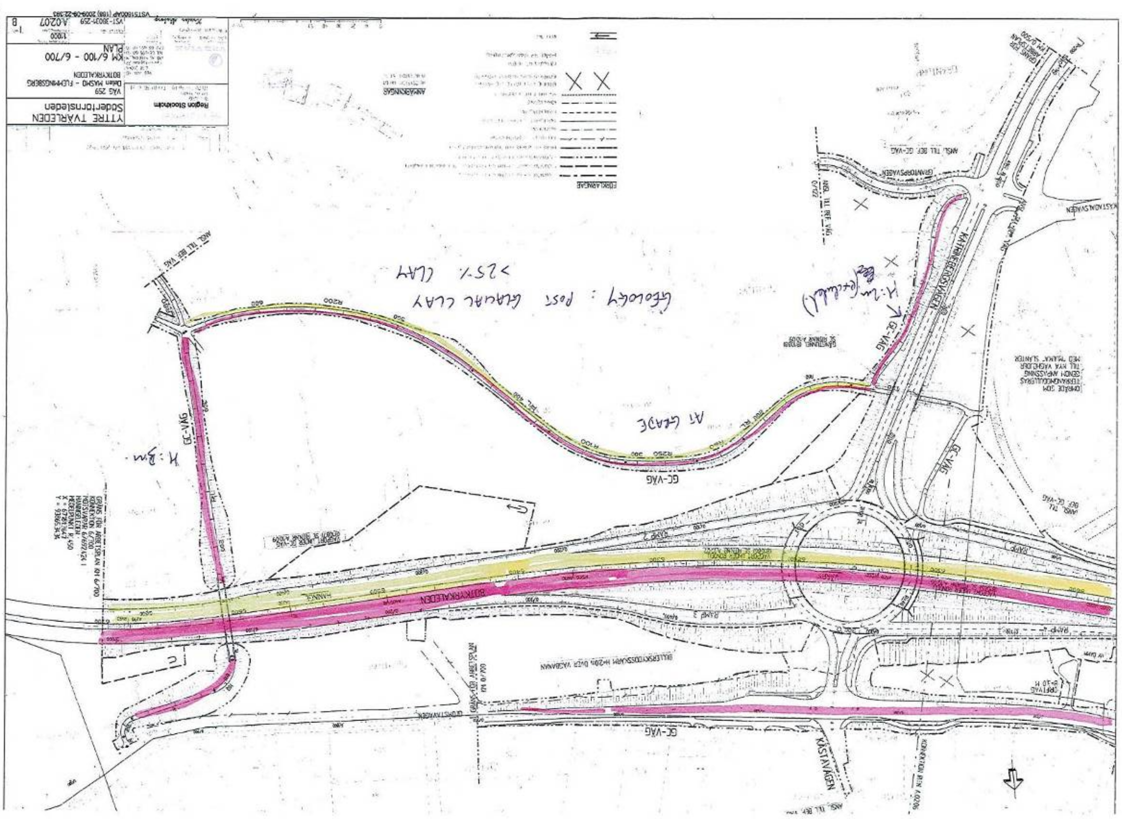

Entré till naturområde
GÖMMARENS NATURRESERVAT utökat 2010
Ny tillfart till Myrstuguberget, cirkulationsplats.
N4
Hög bergsskärning
Stort intrång i RAÄ 151, boplats.
Västra Botkyrkaledens körfält för västergående trafik passerar Masmolänken på bro
Tunnelmynning
RAÄ 357
Bullerskyddsvall, höjd 2 m över väg.
Sammankopplig av stigar.
RAÄ 151
RAÄ 132
GÖMMARENS NATURRESERVAT
RAÄ 334
RAÄ 349
Entré till naturområde
Boplats försvinner.
Bullerskyddsvall, höjd 3 m över väg.
Omläggning av gc-väg, fortsätter längs Västra Botkyrkaleden.
Uppfyllnad och markmodellering vid den befintliga gc-passagen som tas bort.
Ny dagvattendamm för fördröjning och rening innan utsläpp i Masmobäcken. Fjärilslokal försvinner men ny till-skapas strax öster om Botkyrkaleden som kompensationsåtgärd.
Masmobäcken
Vall 3 m + skärm 1 m.
GLÖMSTA
Viltbro för djur och rörligt friluftsliv som planeras i angränsande arbetsplan, Västra Botkyrkaleden.
Bullerskyddsvall, höjd 3 m över väg.
Vall 3 m + skärm 2,3 m. Arbetsplanegräns vid km 3/700. Skärmningsåtgärder fortsätter i angränsande arbetsplan.
0
100
200
300 meter
Naturvärde klass 1
Naturvärde klass 2
Naturvärde klass 3
Fornlämning
Bullerskyddsskärm
Nyckelbiotop
Stig
Naturreservat
Utökat reservat 2010
0/000 Vägens längdmätning
Masmolänken - Kartbilaga MKB-karta 3
Sammanställning av värden, påverkan och åtgärd
Plan Skala 1:3000 i A3 2011-02-14

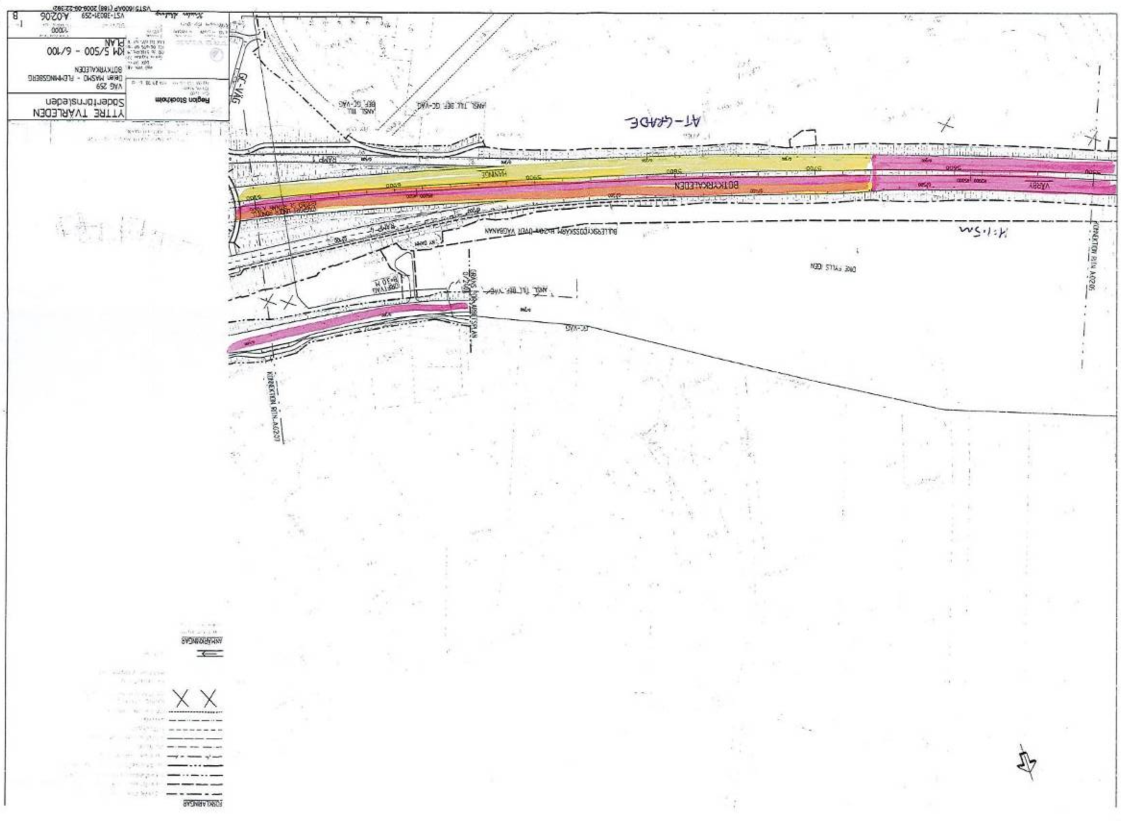

YTTRE TVÄRLEDEN
BOTKYRKALEDEN
GC-VÄG

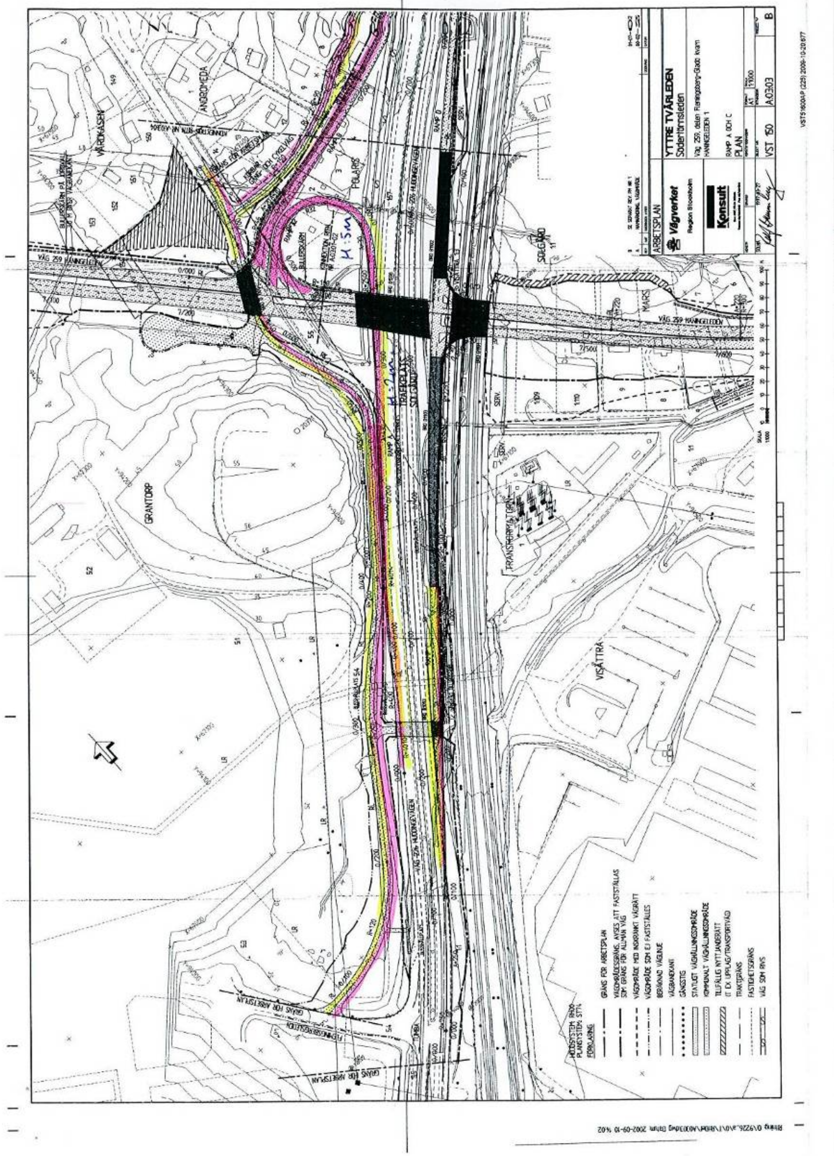
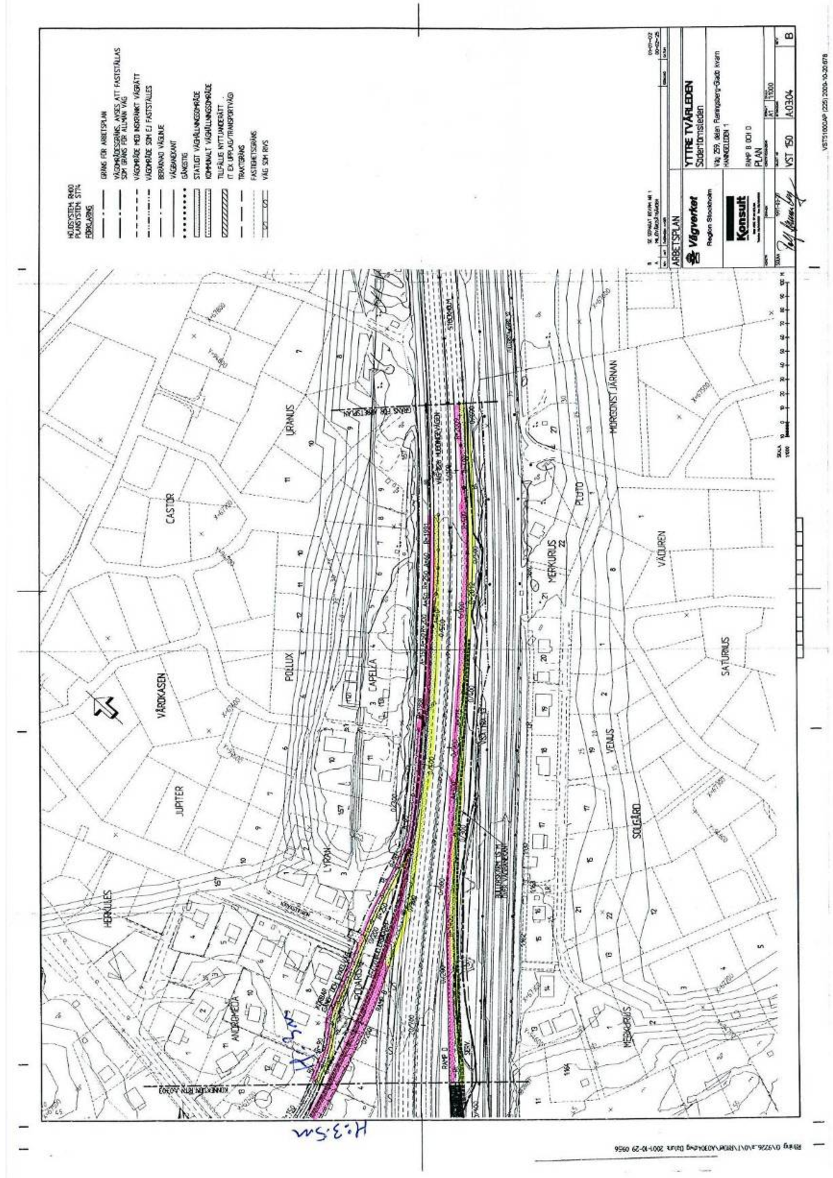

YTTRE TVÄRLEDEN
BOTKYRKALEDEN

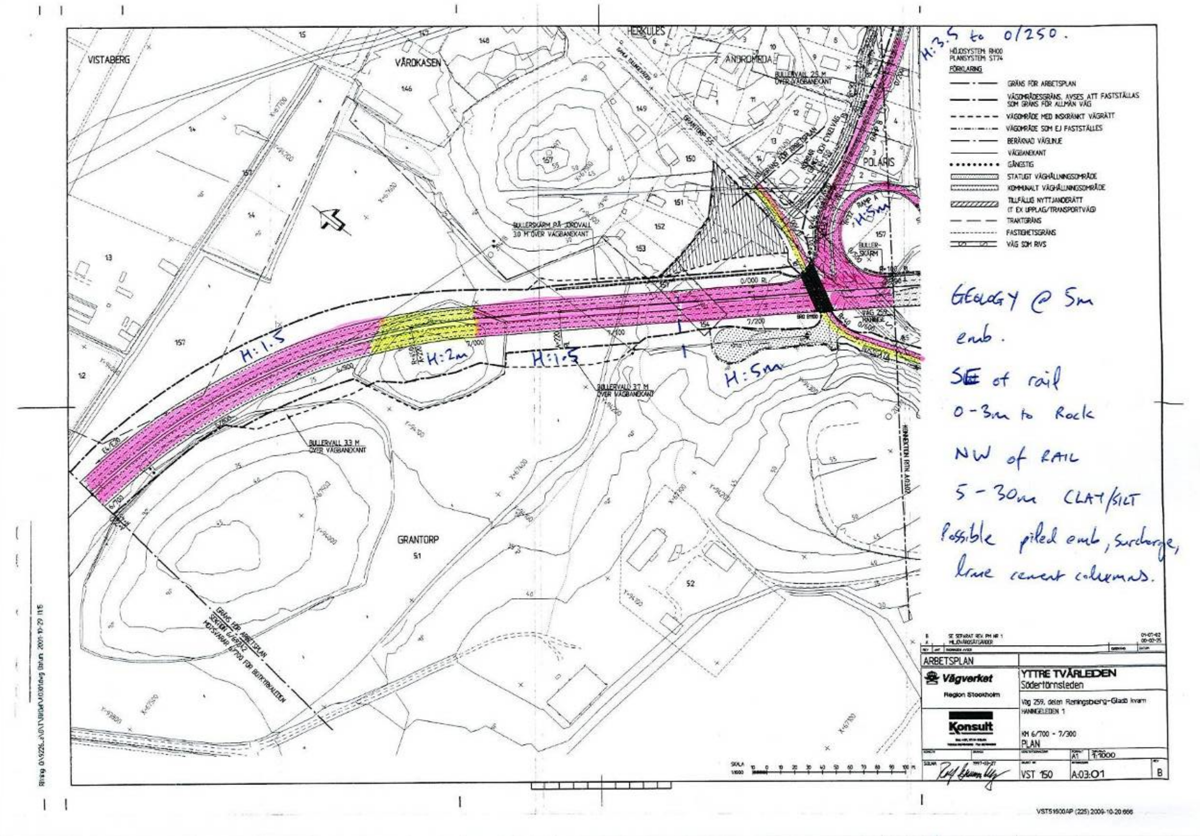

ANMÄRKNING
HÖJDSYSTEM RH 00
TRAFIKKLASS 6
F 3400 m3
J 4710 m3
F 240 m3
MITTRÄCKE H+V
VILTSTÄNGSEL (H+V) H=2.20M
VILTSTÄNGSEL (H) H=2.20M
VÄGRÄCKE V
VÄGRÄCKE H
KONNEKTION RITN A:03:05
KONNEKTION RITN A:03:07
5/708 0 500
BYGGNADS RAMP 1 (AVFART FRÅN VÅRBY)
OCH RAMP 4 (PÅFART MOT VÅRBY)
6/016 0 800
6/016 S 300
VÄGMITT
R=2000
R=5000
A=500
925 mm
YTTRE TVÄRLEDEN
Södertörnsleden
Region Stockholm
VÄG 259
Delen MASMO - FLEMINGSBERG
BOTKYRKALEDEN
KM 5/500-6/100
PROFIL
1:1000/1:100
VST-38031-259
A:03:06
A
VST51600AP (188) 2009-09-22:399

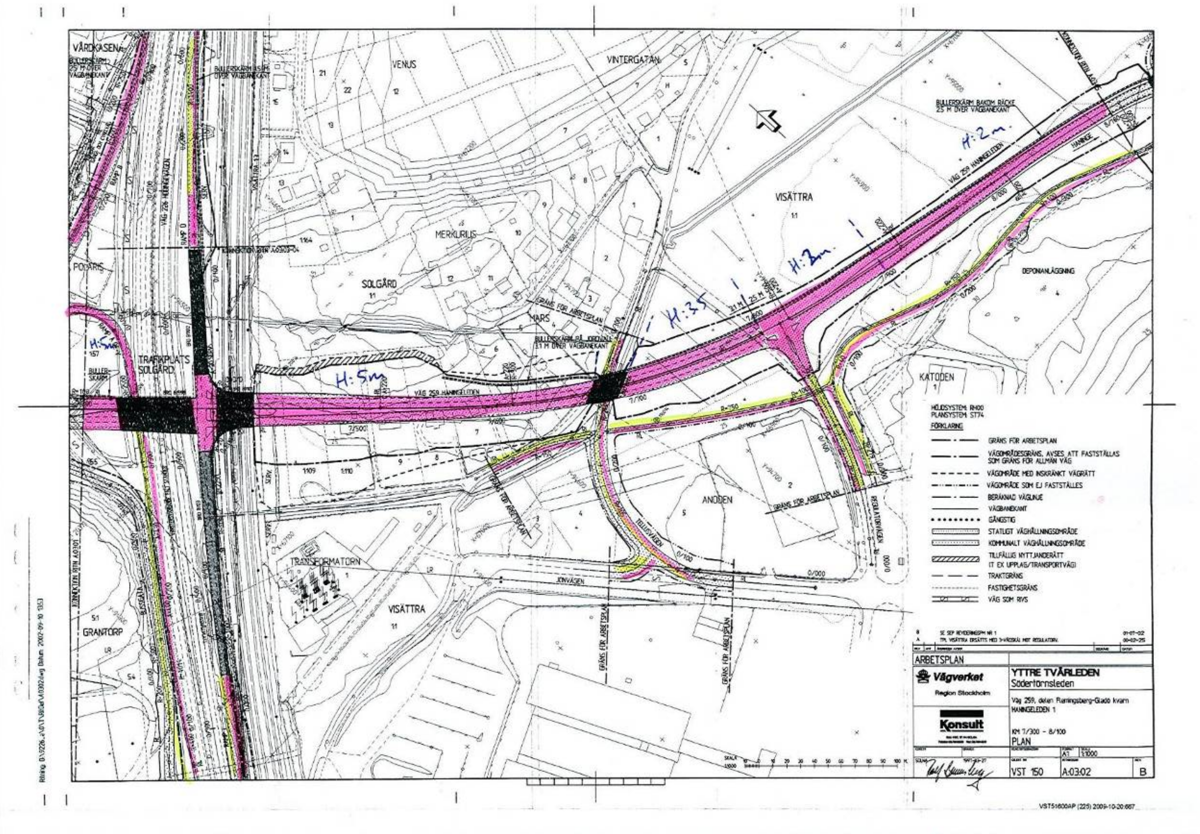

ANMÄRKNING
HÖJDSYSTEM RH 00
TRAFIKKLASS 6
F 10 m3
F 40 m3
J 16700 m3
F 330 m3
F 210 m3
MITTRÄCKE H+V
VILTSTÄNGSEL (H) H=2.20M
VILTSTÄNGSEL (H+V) H=2.20M
VÄGRÄCKE V
VÄGRÄCKE H
TRAFIKPLATS KATRINEBERGSVÄGEN
KONNEKTION RITN A:03:06
KATRINEBERGSVÄGEN
KM 6/715.135
BRO NR B1085
KM 6/711.148
BRO NR B1086
6/250 0 500
BYGGNADS RAMP 2 (PÅFART MOT HANINGE)
6/404 0 500
BYGGNADS RAMP 3 (AVFART FRÅN VÅRBY)
6/472 V 300 I SKYDDSRÄR 600
6/475 V 600 I SKYDDSRÄR 1000
GC-VÄG
BRO NR B1087
6/602 0 500
KM 6/700 GRÄNS FÖR ARBETSPLAN
KONNEKTION 6/700 MOTSVARAR 6/672.424 I HANINGELEDEN
VÄGMITT
A=500
R=1200
A=400
RL
A=230
R=450
925 mm
YTTRE TVÄRLEDEN
Södertörnsleden
Region Stockholm
VÄG 259
Delen MASMO - FLEMINGSBERG
BOTKYRKALEDEN
KM 6/100-6/700
PROFIL
1:1000/1:100
VST-38031-259
A:03:07
A
VST51600AP (188) 2009-09-22:400



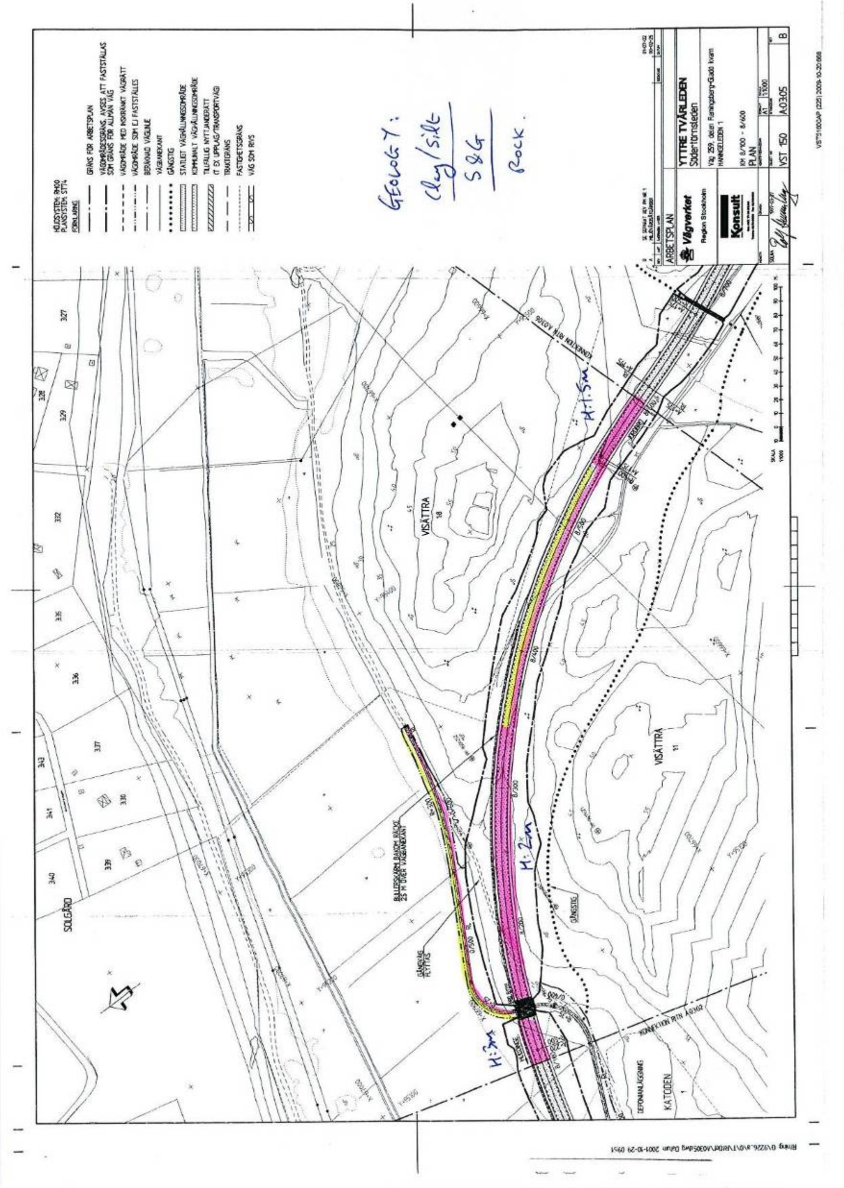


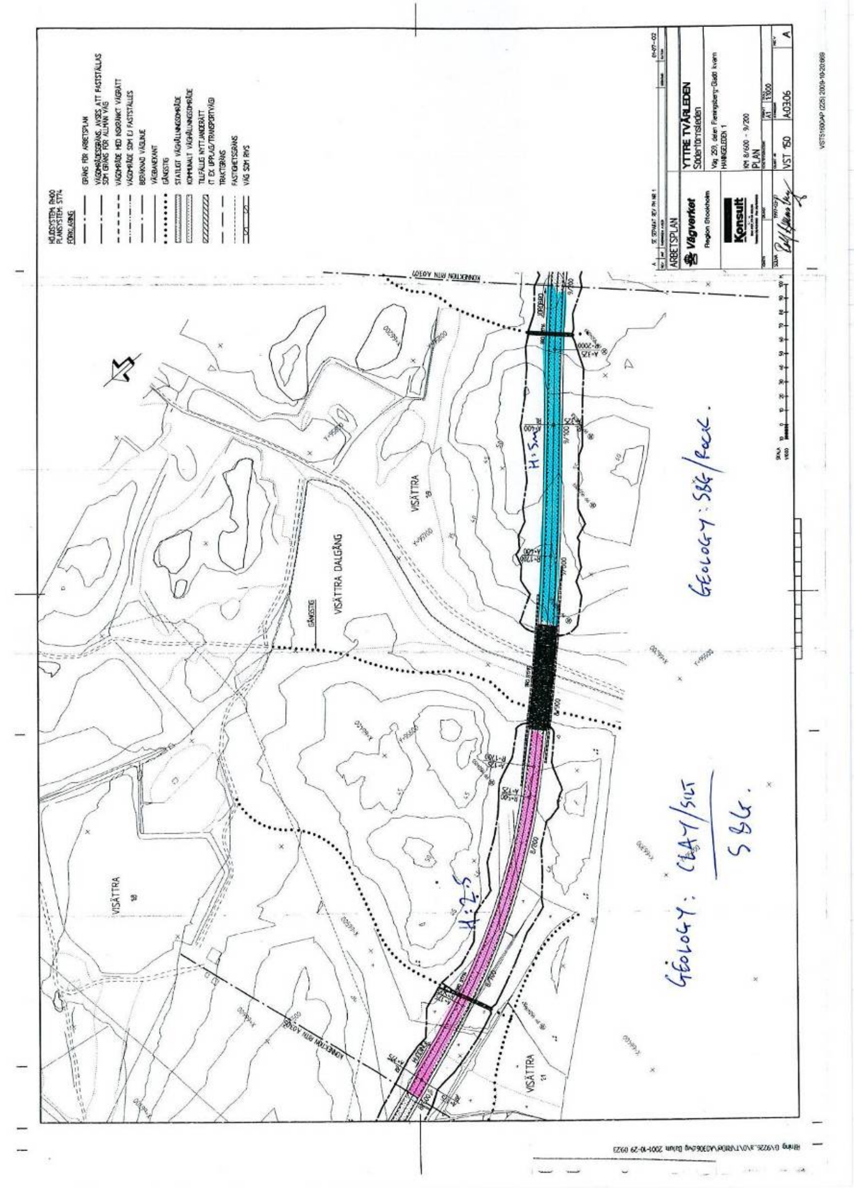

ARBETSPLAN
Vägverket
Region Stockholm
Konsult
YTTRE TVÄRLEDEN
Södertörnsleden
RAMP A OCH C
PLAN
VST 150
A0303
B
GRANTORP
VISÄTTRA
ANDROMEDA
VÅRDKASEN
SOLGÅRD
TRANSFORMATORN
H:5m

ARBETSPLAN
Vägverket
Region Stockholm
Konsult
YTTRE TVÄRLEDEN
Södertörnsleden
RAMP B OCH D
PLAN
VST 150
A0304
B
URANUS
CASTOR
POLLUX
CAPELLA
VÅRDKASEN
JUPITER
HERKULES
ANDROMEDA
MORGONSTJÄRNAN
PLUTO
MERKURIUS
VÄDUREN
VENUS
SATURNUS
SOLGÅRD
H:3.5m

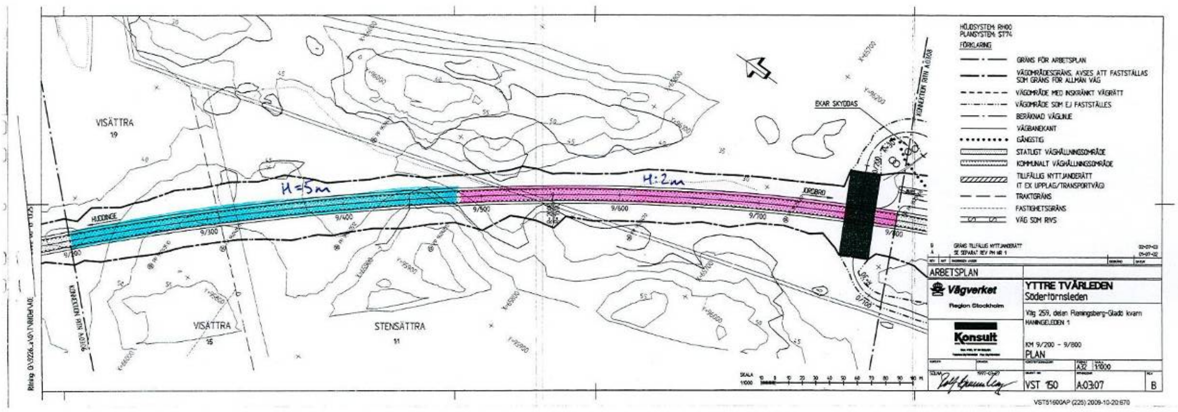

H:3.5 to 0/250.
GEOLOGY @ 5m
emb.
SE of rail
0-3m to Rock
NW of RAIL
5-30m CLAY/SILT
Possible piled emb, surcharge,
lime cement columns.
H:1.5
H:2m
H:5m
VISTABERG
VÅRDKASEN
ANDROMEDA
POLARIS
GRANTORP
ARBETSPLAN
Vägverket
Region Stockholm
YTTRE TVÄRLEDEN
Södertörnsleden
Konsult
PLAN
VST 150
A:03:01
B


H:2m.
H:3m
H:3.5
H:5m
VÅRDKASEN
VENUS
VINTERGATAN
VISÄTTRA
MERKURIUS
SOLGÅRD
TRAFIKPLATS SOLGÅRD
POLARIS
KATODEN
ANODEN
TRANSFORMATORN
GRANTORP
DEPONIANLÄGGNING
ARBETSPLAN
Vägverket
Region Stockholm
YTTRE TVÄRLEDEN
Södertörnsleden
Konsult
KM 7/300 - 8/100
PLAN
VST 150
A:03:02
B

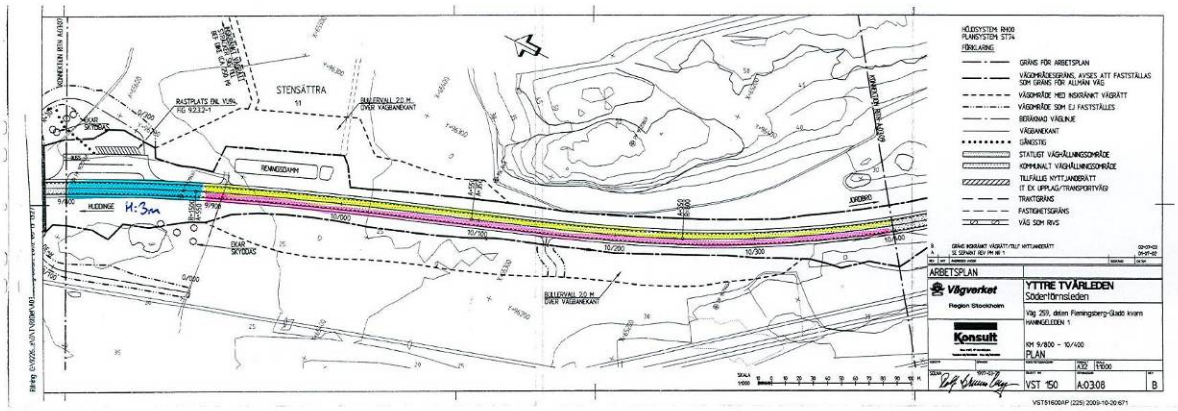
A5-8


ARBETSPLAN
YTTRE TVÄRLEDEN
Södertörnsleden
PLAN
VST 150
A0305
GEOLOGY: Clay/silt
SBG
Rock.
H:1.5m
H:2m
H:3m
VISÄTTRA
KATODEN
SOLGÅRD

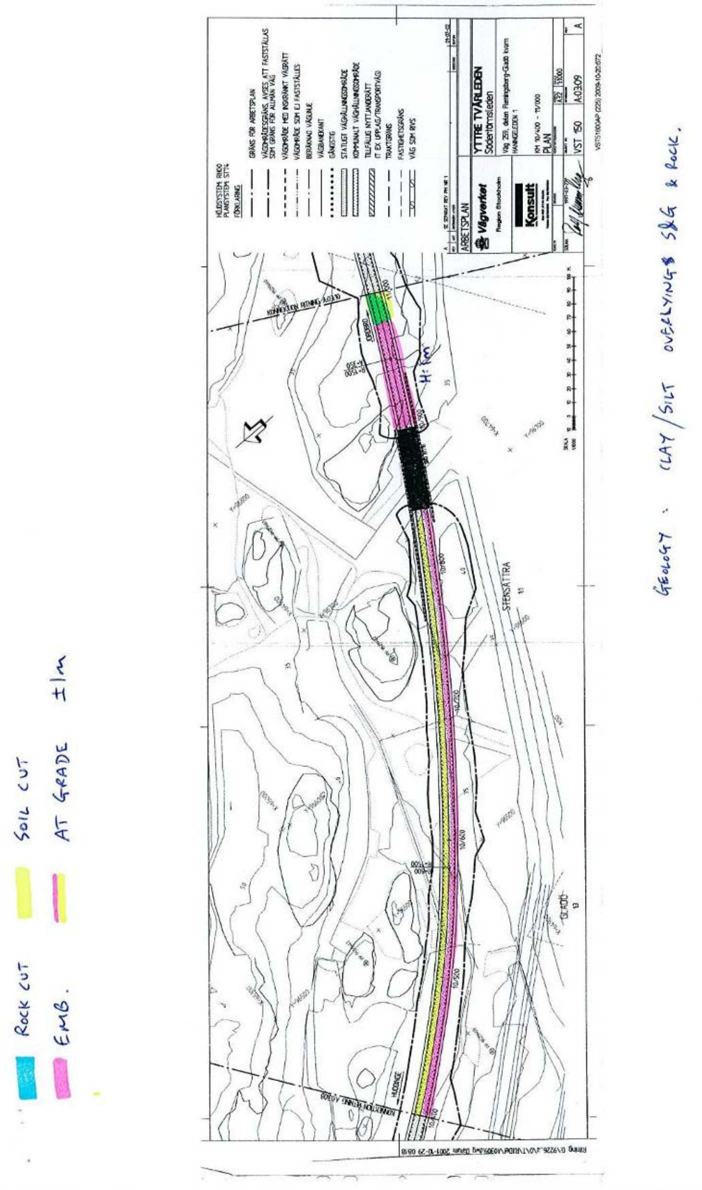

ARBETSPLAN
YTTRE TVÄRLEDEN
Södertörnsleden
PLAN
VST 150
A0306
GEOLOGY: SBG/Rock
GEOLOGY: CLAY/SILT
SBG.
H:1.5m
H:2.5
VISÄTTRA
VISÄTTRA DALGÅNG

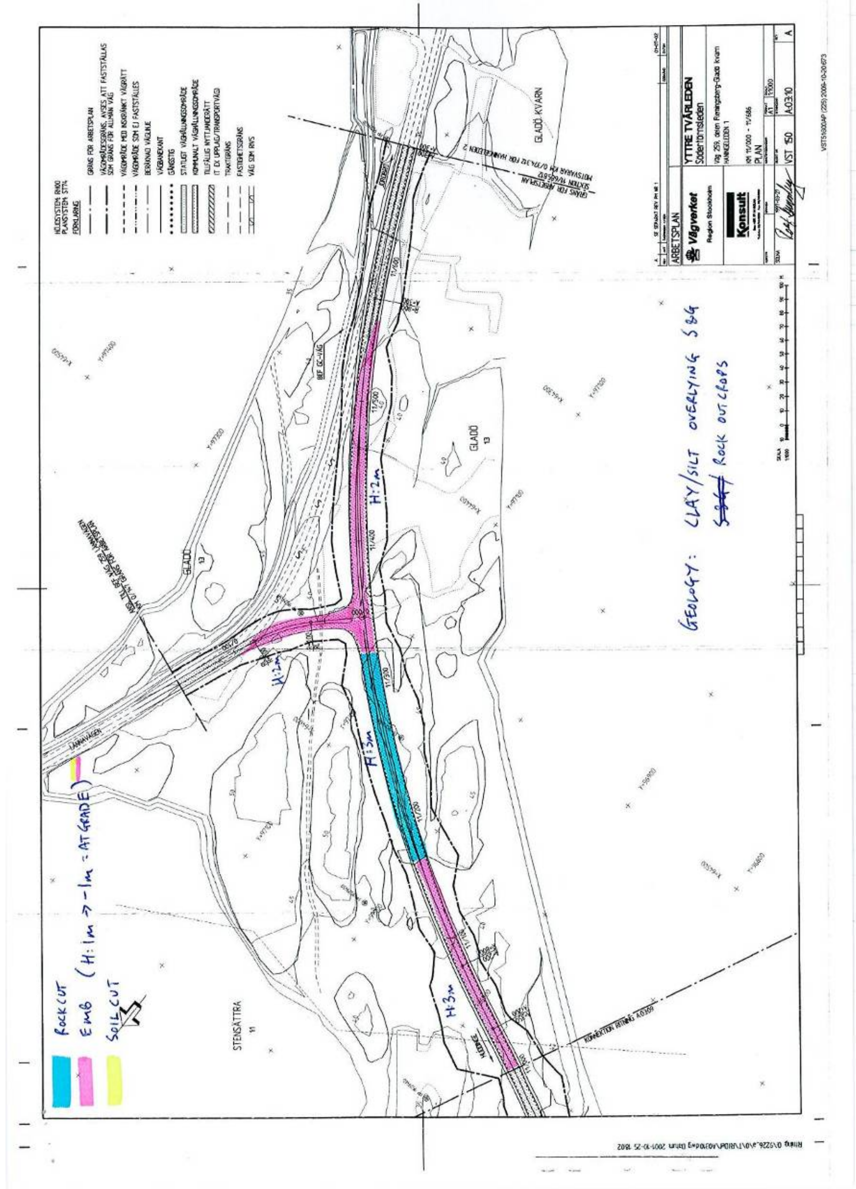


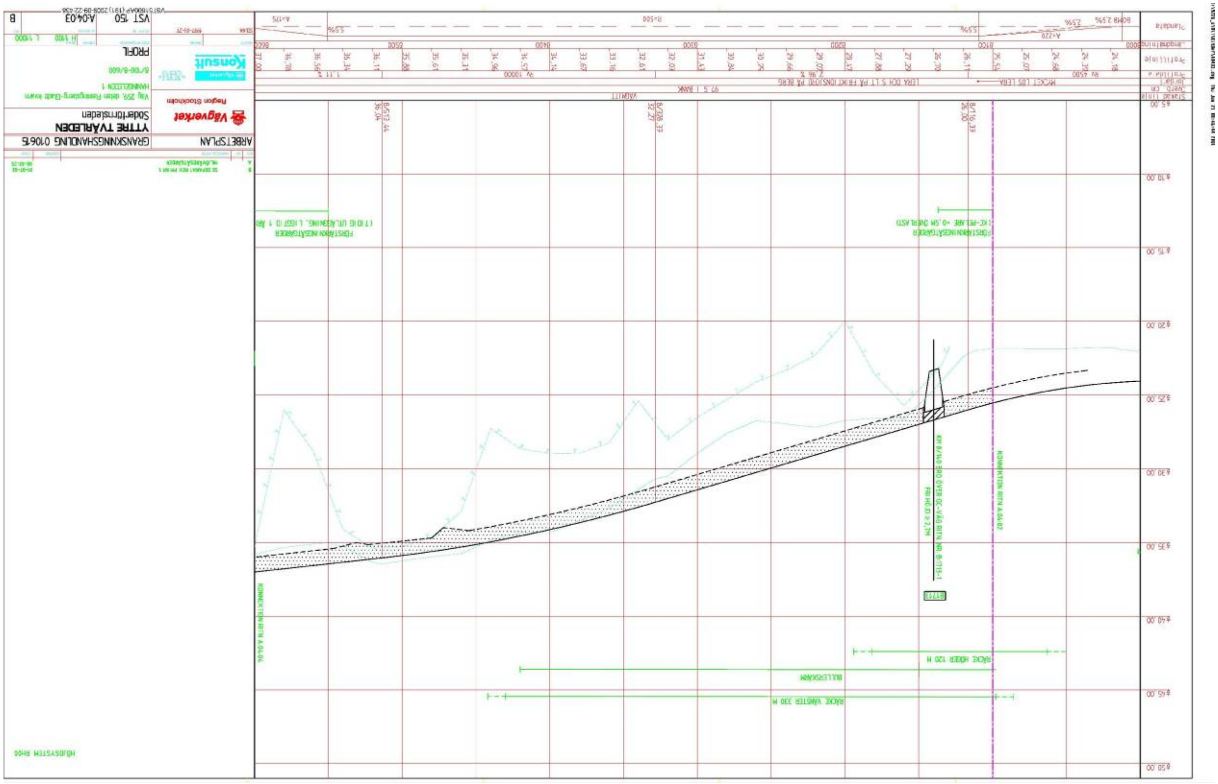
GEOLOGY : SILT/CLAY
S&G
ROCK.

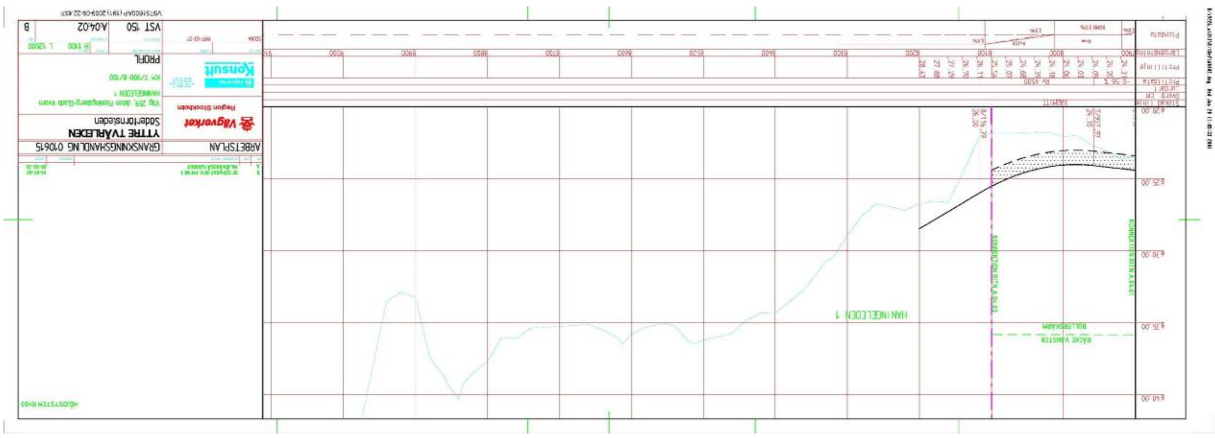


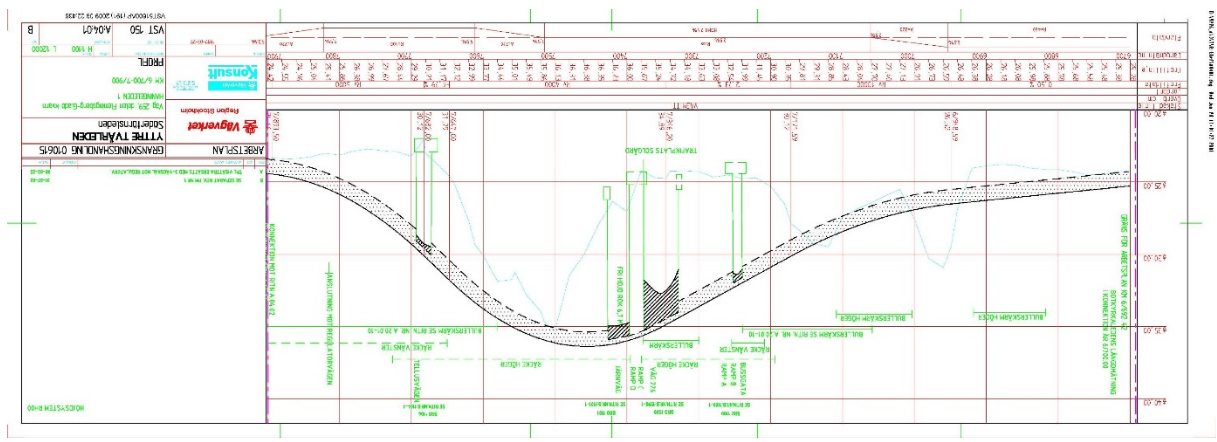
GEOLOGY: CLAY/SILT OVER S&G OVER ROCK.


ROCK CUT
EMB.
SOIL CUT
AT GRADE ±1m
H: 1m
GEOLOGY: CLAY/SILT OVERLYING S&G & ROCK.
YTTRE TVÄRLEDEN
Södertörnsleden
ARBETSPLAN
Vägverket
Konsult
PLAN
VST 150
A0309
STENSÄTTRA
GLADÖ

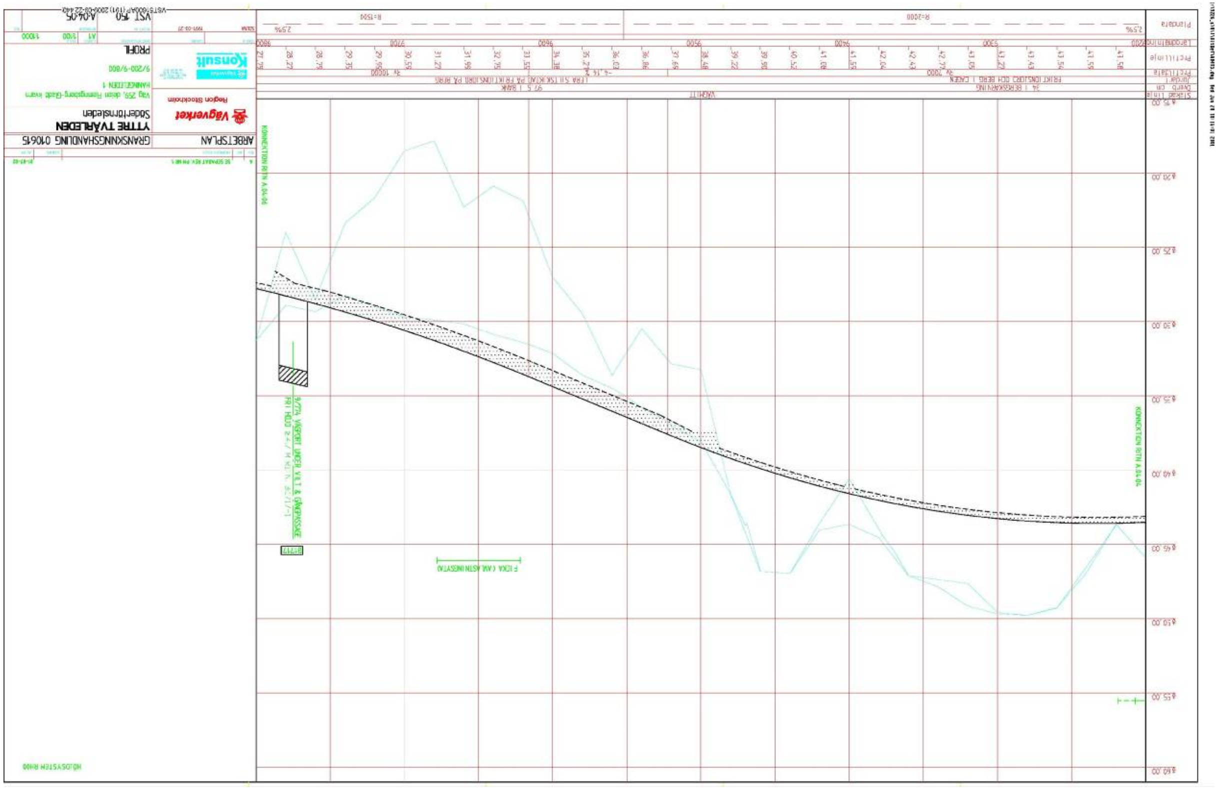

ROCK CUT
EMB (H: 1m → -1m = AT GRADE)
SOIL CUT
H: 2m
H: 3m
H: 1m
GEOLOGY: CLAY/SILT OVERLYING S&G
~~S&G~~ ROCK OUTCROPS
YTTRE TVÄRLEDEN
Södertörnsleden
ARBETSPLAN
Vägverket
Konsult
PLAN
VST 150
A0310
GLADÖ KVARN
GLADÖ
STENSÄTTRA
FARNAVÄGEN

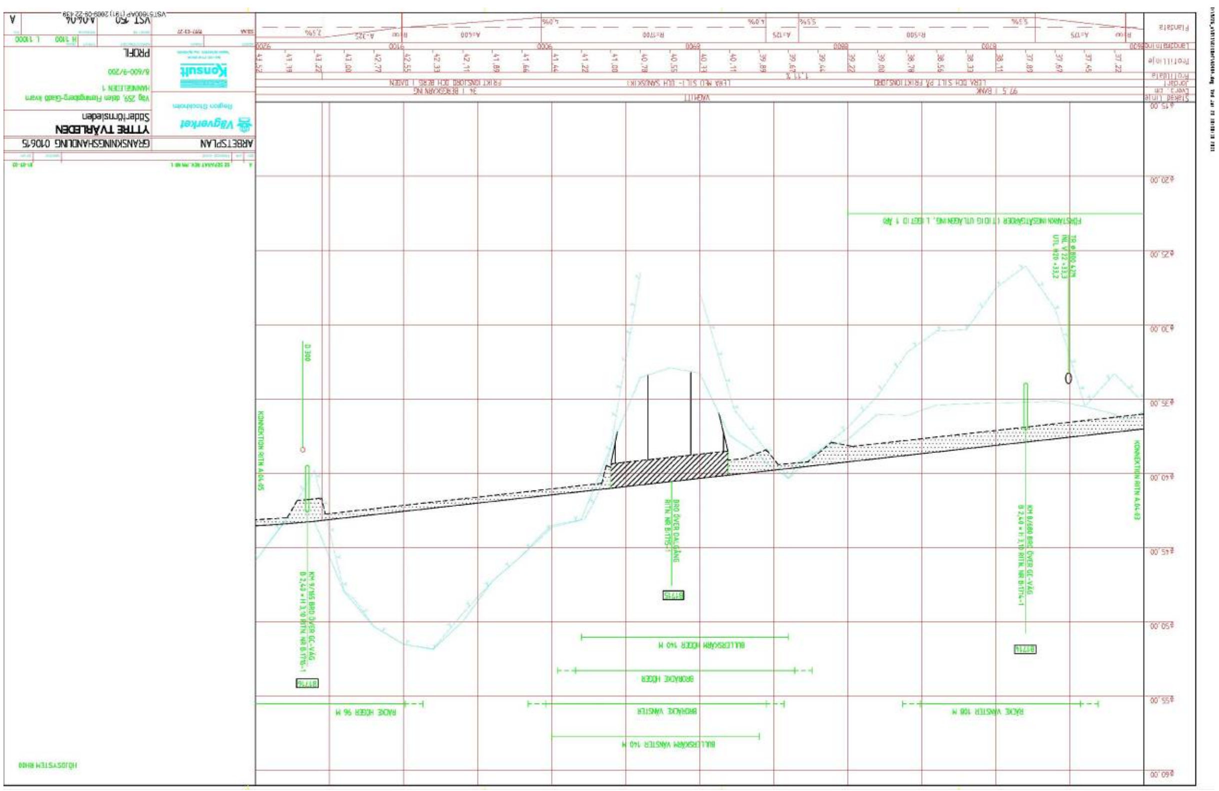


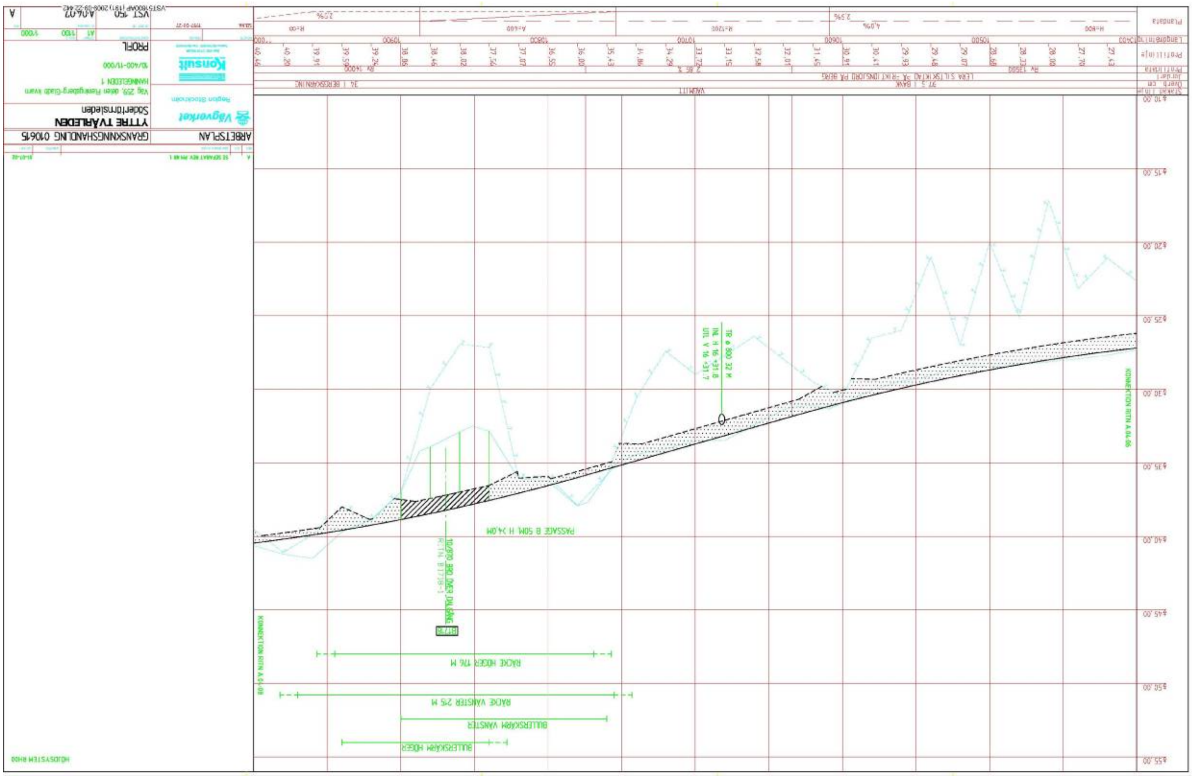


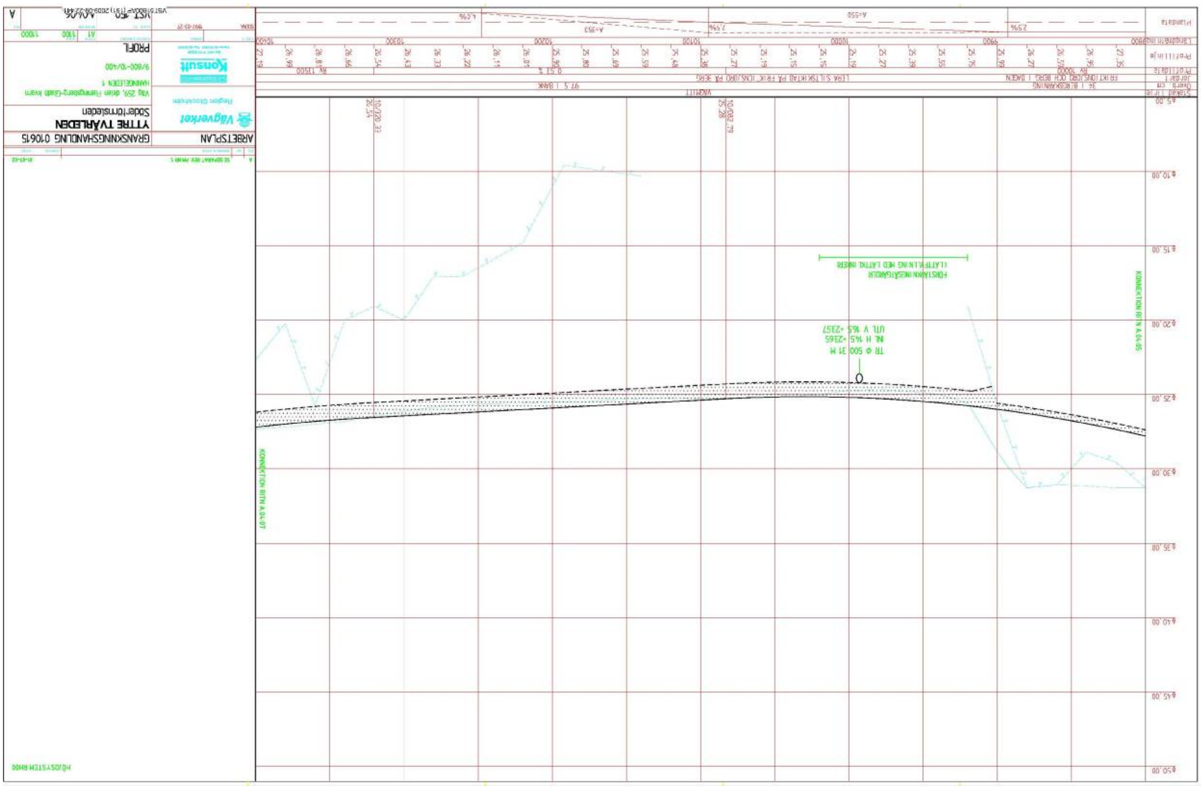


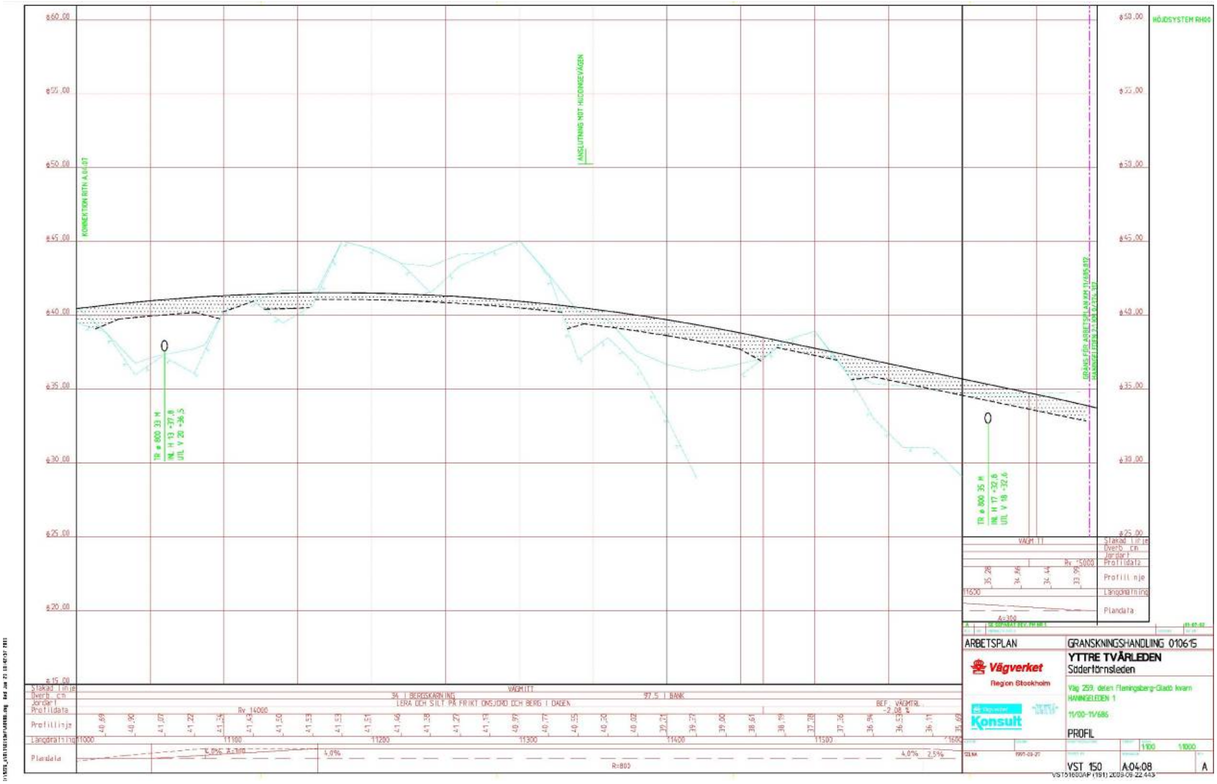
A5-12

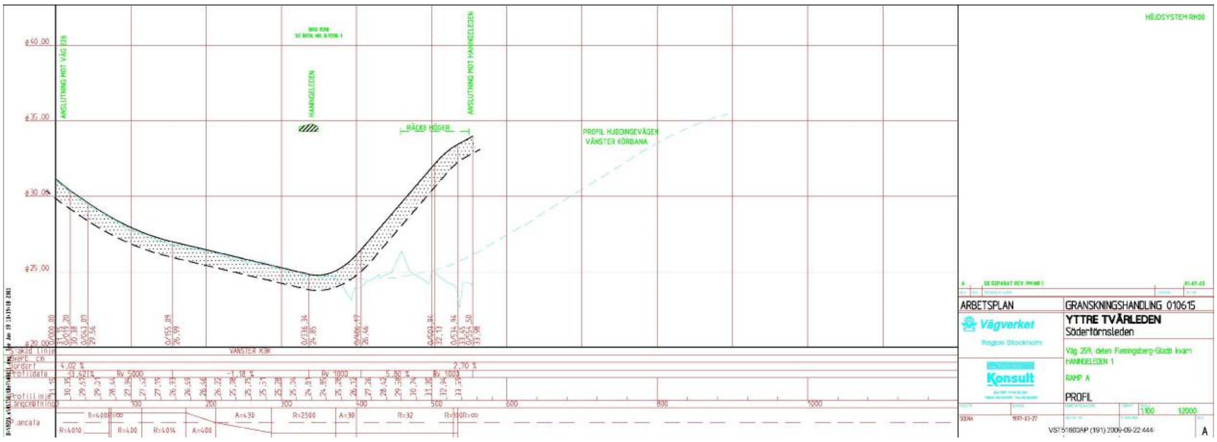


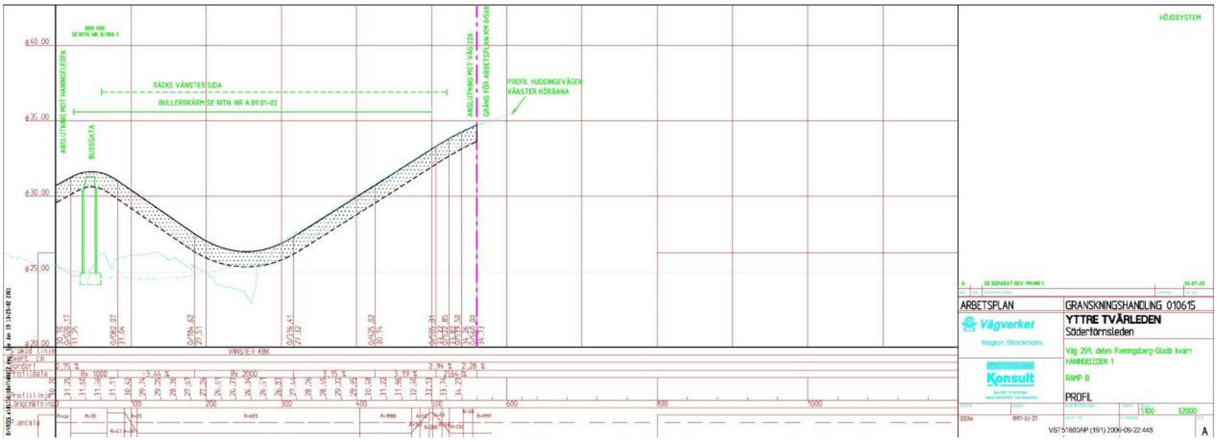


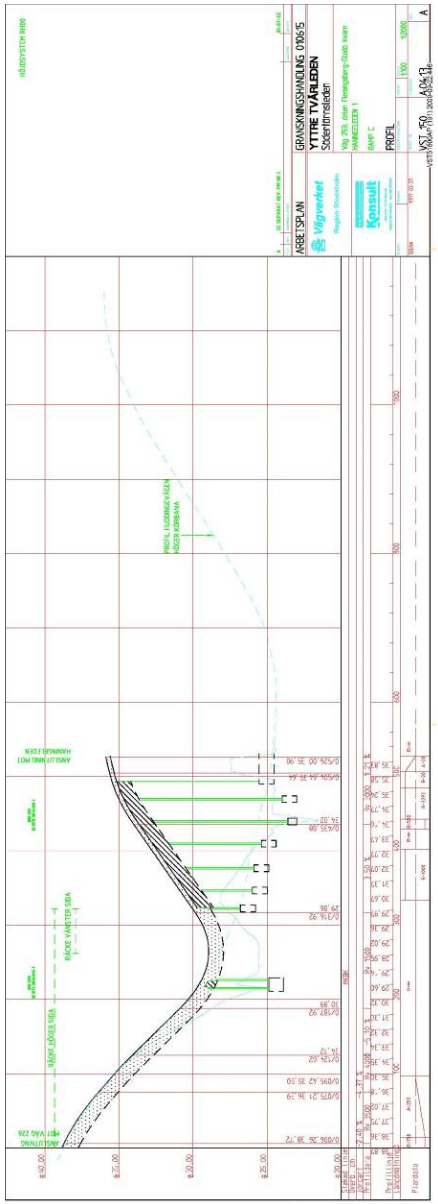


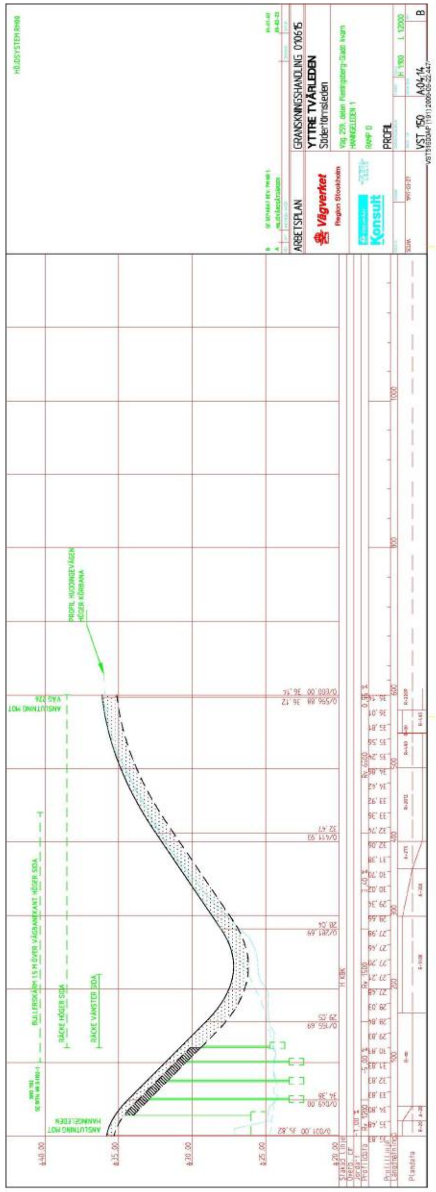



ARBETSPLAN
GRANSKNINGSHANDLING 010615
YTTRE TVÄRLEDEN
Södertörnsleden
Vägverket
Region Stockholm
Väg 259, delen Flemingsberg-Gladö kvarn
HANINGELEDEN 1
11/00-11/686
Konsult
PROFIL
VST 150
A:04:08
A
HÖJDSYSTEM RH00
KONNEKTION RITN A:04:07
ANSLUTNING MOT HUDDINGEVÄGEN
VÄGMITT
LERA OCH SILT PÅ FRIKT ONSJORD OCH BERG I DAGEN

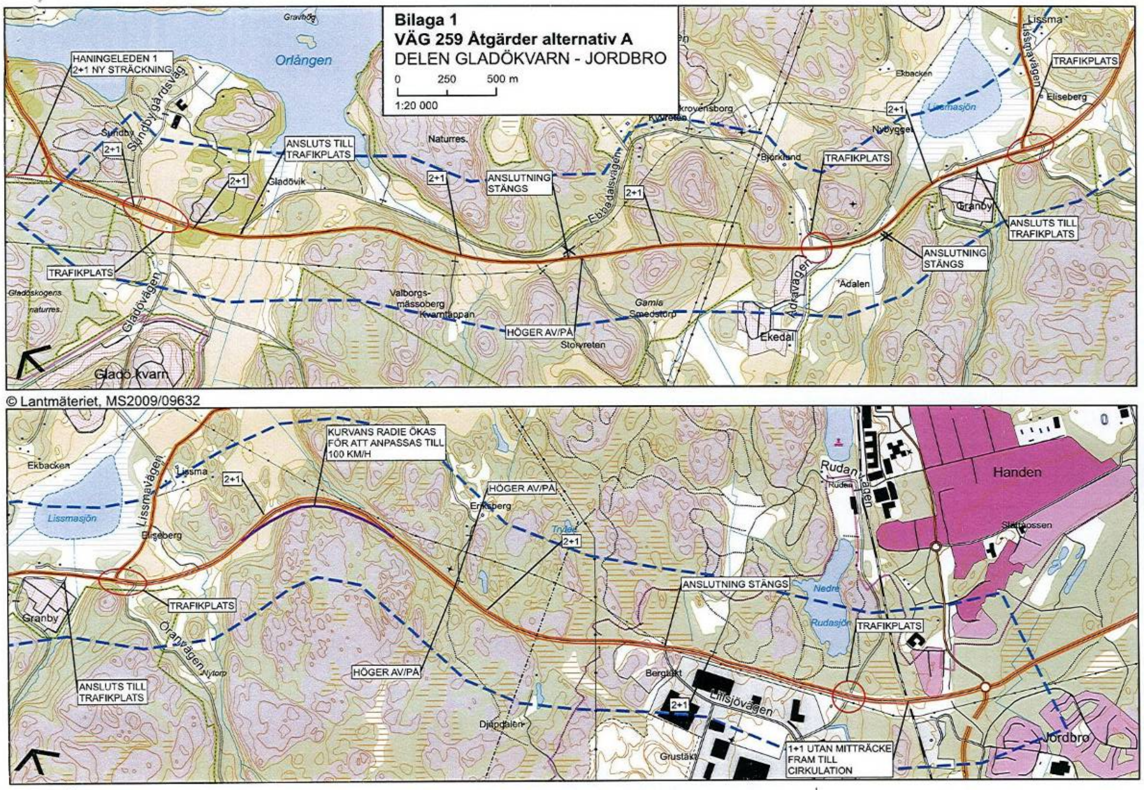

ARBETSPLAN
GRANSKNINGSHANDLING 010615
YTTRE TVÄRLEDEN
Södertörnsleden
Vägverket
Region Stockholm
Väg 259, delen Flemingsberg-Gladö kvarn
HANINGELEDEN 1
Konsult
RAMP A
PROFIL
A
HÖJDSYSTEM RH00
ANSLUTNING MOT VÄG 226
HANINGELEDEN
ANSLUTNING MOT HANINGELEDEN
RÄCKE HÖGER
PROFIL HUDDINGEVÄGEN
VÄNSTER KÖRBANA
VÄNSTER KBK


ARBETSPLAN
GRANSKNINGSHANDLING 010615
YTTRE TVÄRLEDEN
Södertörnsleden
Vägverket
Region Stockholm
Väg 259, delen Flemingsberg-Gladö kvarn
HANINGELEDEN 1
Konsult
RAMP B
PROFIL
A
HÖJDSYSTEM
ANSLUTNING MOT HANINGELEDEN
BUSSGATA
RÄCKE VÄNSTER SIDA
BULLERSKÄRM SE RITN. NR A:09:01-02
ANSLUTNING MOT VÄG 226
GRÄNS FÖR ARBETSPLAN KM 0/500
PROFIL HUDDINGEVÄGEN
VÄNSTER KÖRBANA
VÄNSTER KBK

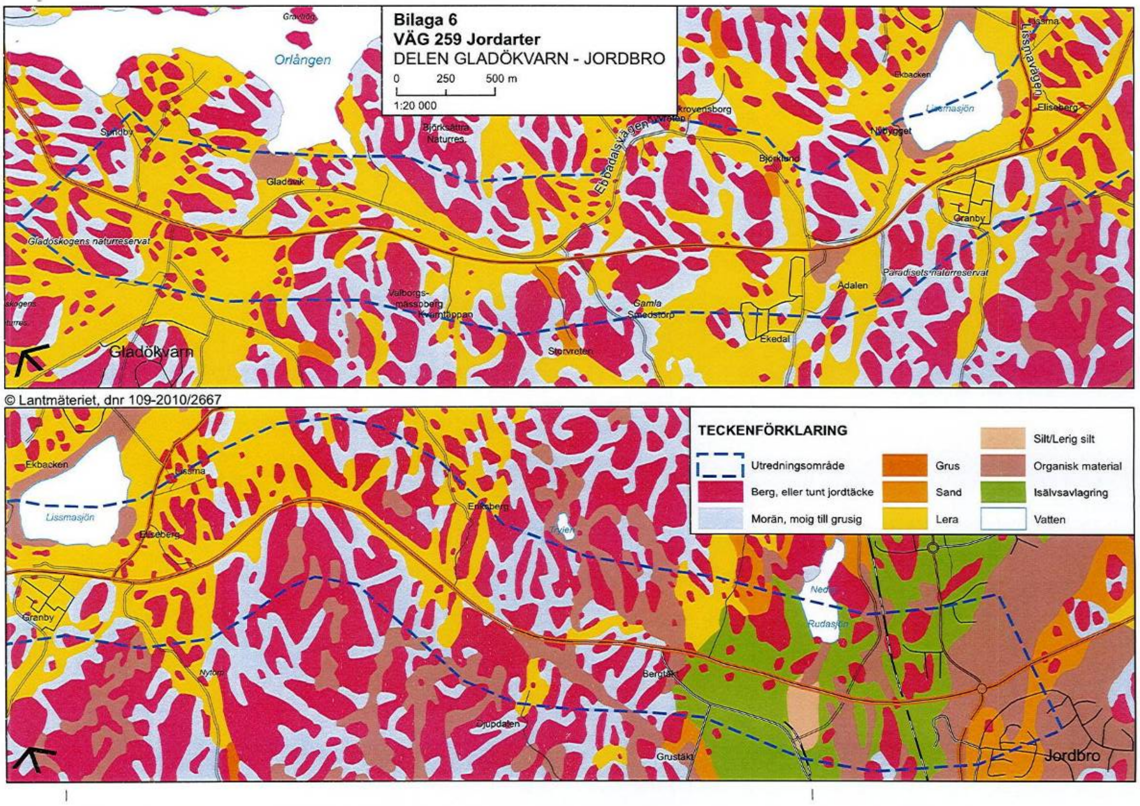

ARBETSPLAN
GRANSKNINGSHANDLING 010615
YTTRE TVÄRLEDEN
Södertörnsleden
Vägverket
Konsult
RAMP C
PROFIL
VST 150
A04:13
A


ARBETSPLAN
GRANSKNINGSHANDLING 010615
YTTRE TVÄRLEDEN
Södertörnsleden
Vägverket
Region Stockholm
Konsult
RAMP D
PROFIL
VST 150
A04:14
B

A5-16



© Lantmäteriet, MS2009/09632



© Lantmäteriet, dnr 109-2010/2667

Appendix 6: Earthworks Quantity Estimates for Cross-Connection Södertörn

(Bespoke Spreadsheet)

Masmolänken

Road Chainage		Mainline			Tunnel N			Tunnel S			Mainline		E4/E20 Widening	Total
From		3600	3440	2900	2750	2310	2210	2740	2310	2210	1800	1750	7000	
To		3440	2900	2745	2310	2210	1800	2310	2210	1800	1750	1700	7800	
Length		160	540	155	440	100	410	430	100	410	50	50	800	
Construction Type		At-Grade	At-Grade	Cut	Tunnel	Tunnel	Tunnel	Tunnel	Tunnel	Tunnel	Cut	Emb	At-Grade	
Geometry														
Overall														
No of lanes		3	4	4	2	2	2	2	2	2	4	4	10	
Lane width		3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	
Central Reserve		2.5	2.5	8	0	0	0	0	0	0	6	6	12	
Hard strip		0.5	0.5	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.5	0.5	0.5	
Hard shoulder		2	2	2							1	1	1	
Verge (assume)		1	1	1	1	1	1	1	1	1	1	1	1	
Road width (incl. verges)		20	23.5	29	9.5	9.5	9.5	9.5	9.5	9.5	25	25	52	
Embankment														
Average height												3		
Side slope	1:											2		
Cutting														
Cutting height				6							4			
Cutting side slopes (Rock)	1:			0.75							0.75			
Cutting side slopes (Soil)	1:			0.75							0.75			
%Clay/Silt				0%							0%			
%Sand/Gravel				40%							40%			
% Rock				60%							60%			
At-grade/transition														
Excavation depth		1	1										0.5	
%Clay/Silt		0%	0%										20%	
%Sand/Gravel		100%	100%										80%	
%Rock		0%	0%										0%	
Additional sub-grade excavation														
Excavation depth														
Tunnel														
Cross-sectional area					66.53	66.53	66.53	66.53	66.53	66.53				
Tunnel construction (D&B,TBM, Exc)					D&B	D&B	D&B	D&B	D&B	D&B				
Assumed % overbreak					10%	10%	10%	10%	10%	10%				
Clay/Silt					0%	0%	0%	0%	0%	0%				
Sand/Gravel					10%	70%	10%	10%	70%	10%				
Rock					90%	30%	90%	90%	30%	90%				
Widening														
Existing Road Width														
Additional lateral excavation														
Widening width (excl. Verge)														
Vertical Alignment														

Capping and sub-base													
cuttings	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	
emb	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	
at grade	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,4	
Pavement (Bound)													
Thickness	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	
% of Aggregates	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	
Material Required													
Processed rock fill/m	18,00	21,15	8,70	0,00	0,00	0,00	0,00	0,00	0,00	7,50	18,48	20,80	
General Embankment fill/m											65,22		
Pavement	4,65	5,7	5,7	2,25	2,25	2,25	2,25	2,25	2,25	5,1	5,1	11,4	
Compacted Volume													
Processed rock fill (m^3)	3512,40	14037,30	2099,48	841,50	191,25	784,13	822,38	191,25	784,13	591,75	1140,75	24392,00	49388,3
General Embankment fill (m^3)	0	0	0	0	0	0	0	0	0	0	3261	0	3261
Total													52649,3
Transport Bulk Volumes													
Processed rock fill (m^3)	4502,701667	17995,03875	2691,410313	1078,75625	245,171875	1005,204688	1054,239063	245,171875	1005,204688	758,590625	1462,378125	31269,18889	63313,05681
General Embankment fill (m^3)	0	0	0	0	0	0	0	0	0	0	4124,835806	0	4124,835806
Total													67437,89261
Total mass													
Processed rock fill (T)	6849,18	27372,735	4093,97625	1640,925	372,9375	1529,04375	1603,63125	372,9375	1529,04375	1153,9125	2224,4625	47564,4	96307,185
General Embankment fill (T)	0	0	0	0	0	0	0	0	0	0	6522	0	6522
Total													102829,185
Material Excavated													
Rock /m	0,00	0,00	114,12	65,86	21,95	65,86	65,86	21,95	65,86	64,32	0,00	0,00	
Granular (Sand/Gravel) /m	20,00	23,50	86,88	7,32	51,23	7,32	7,32	51,23	7,32	47,68	0,00	20,80	
Cohesive (Clay/Silt) /m	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,20	
Burrow Volume													
Rock (m^3)	0,00	0,00	17688,60	28980,47	2195,49	27004,53	28321,82	2195,49	27004,53	3216,00	0,00	0,00	136606,923
Granular (Sand/Gravel) (m^3)	3200,00	12690,00	13466,40	3220,05	5122,81	3000,50	3146,87	5122,81	3000,50	2384,00	0,00	16640,00	70993,947
Cohesive (Clay/Silt)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4160,00	4160
Total													211760,87
After Swelling/Bulking													
Rock (m^3)	0,00	0,00	31397,27	51440,33	3896,99	47933,04	50271,23	3896,99	47933,04	5708,40	0,00	0,00	242477,2883
Granular (Sand/Gravel) (m^3)	4000,00	15862,50	16833,00	4025,07	6403,51	3750,63	3933,59	6403,51	3750,63	2980,00	0,00	20800,00	88742,43375
Cohesive (Clay/Silt)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5408,00	5408
Total													336627,7221
Total mass													
Rock (T)	0,00	0,00	47759,22	78247,26	5927,82	72912,22	76468,92	5927,82	72912,22	8683,20	0,00	0,00	368838,6921
Granular (Sand/Gravel) (T)	5880,00	23317,88	24744,51	5916,85	9413,16	5513,42	5782,37	9413,16	5513,42	4380,60	0,00	30576,00	130451,3776
Cohesive (Clay/Silt)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	9152,00	9152
Total													508442,0697

Notes

Particular Geology

CH2900-3600 overlying postglacial sands.

Southern tunnel portal within glaciofluvial gravel. Depth to bedrock typically 0-3m

Assumptions

General Assumptions

Assume embankments require 0.7m nominal processed rock for capping and sub-base (400mm capping, 300mm sub-base) [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), Trafikklass 5]

Assume at-grade construction requires 0.9m nominal processed rock for capping and sub-base (600mm capping, 300mm sub-base) [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), trafikklass 5]

Assume at-grade construction requires 0.9m nominal processed rock for capping and sub-base (600mm capping, 300mm sub-base) [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), 500-1500 vehicles per day (<1msa)]

Assume only sub-base required in cuttings beyond transition zone (i.e. 300mm sub-base)

Assume embankments over 4m height over clays/silts require either excavation to granular soils/rock or ground improvement. Engineering judgement to be made based on soil and depth to bedrock maps

For retaining walls/reinforced earth walls, set side slope to 0 (for both sides) or half design slope (for RW on one side only)

Assumed pavement thickness of 0.3m [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), Trafikklass 5]

Assumed pavement thickness of 0.3m [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), 500-1500 vehicles per day (<1msa)]

Assumed 85% of pavement comprises processed rock

No distinction has been made between consolidated and unconsolidated in-situ soils. The mass has been determined by the average bulk density (after applying swell factors)

Assume general fill comprises granular and cohesive soils

Assume lower swelling factor for delivered material (dry/unsaturated soils)

Assume lower bulk density value for delivered material (unsaturated)

Compaction Densities obtained from Geoguide 1. Selected Compaction Density is the lesser of: Average Compaction Density and Burrow Density

Compaction Factor = Compaction Density/Loose Bulk Density. General Fill Loose Bulk Density Assumed from 50% Granular, 50% Cohesive. Used to obtain transportation volumes

Till is assumed to be reusable as general fill. In the case of Cross-connection Södertörn, till encountered is very limited. Where encountered and excavated, the till has been split into rock and cohesive with a split of 30/70.

Particular Assumptions

Assume 1V:0.75H at tunnel portals and no cut and cover portion

Tunnel with horseshoe section with 1m verges and 0,25m hard strips. (Adopting Norwegian Tunnel type T9.5)

Construction road to sand and gravel cut and cover tunnel between CH2210 and 2310 and potential volume S&G material gained beyond tunnel envelope is ignored.

Assumptions made on widening. Paved lanes averaged to 10 (8 to 12). Central reserve averaged from maps (25 max, 2 min, 12 avg). Entire widened road to be resurfaced.

Widening over existing embankment assumes reduced excavation of 0.5m to account for areas that require only nominal excavation

Summary

Excavated			Required	
Loose Rock (T)	Loose Sands and Gravels (T)	Loose Silts/Clays (T)	Loose Crushed Rock (T)	Loose General Embankment Fill (T)
368838,6921	130451,3776	9152	96307,185	6522

Botkyrkaleden

Road Chainage		Mainline							Ramp 1	Ramp 2	Ramp 3	Ramp 4	Katrinebergs Vägen				Roundabout			GC-Väg (Glömstavägen widening)			GC-Väg (South)	GC-Väg (East)		Total
From		3800	4300	5500	5650	5920	6400	6600	300	0	300	0	0	150	200	300	0	100	250	240	360	540	100	0	180	
To		4300	5500	5650	5920	6400	6600	6700	500	200	490	200	60	200	300	500	40	200	300	360	540	700	650	120	360	
Length		500	1200	150	270	480	200	100	200	200	190	200	60	50	100	200	40	100	50	120	180	160	550	120	180	
Construction Type		At-Grade	At-Grade	Emb	At-Grade	At-Grade	At-Grade	At-Grade	Emb	Emb	Emb	Emb	Emb	Emb	Emb	At-Grade	Emb	Emb	Emb	Emb	Emb	Emb	At-Grade	Emb	Emb	
Geometry																										
Overall																										
No of lanes		2	4	4	5	4	5	4	1	1	1	1	2	4	4	3	1	1	1	1	2	1	1	1	1	
Lane width		3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3	3	3	
Central Reserve		2.5	2.5	2.5	2.5	2.5	2.5	2.5	0	0	0	0	5	8	2.5	2.5	0	0	0	0	0	0	0	0	0	
Hard strip		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0	0	0	
Hard shoulder		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	
Verge (assume)		1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	3	3	3	0	0	0	0	0	0	
Road width (incl. verges)		16.5	23.5	23.5	27	23.5	27	23.5	6	6	6	6	17	29.5	21.5	18	9	9	9	3.5	7	3.5	3	3	3	
Embankment																										
Average height				1.5					4	4	4	4	6	6	4		6	6	6	2	4	3		3	3	
Side slope	1:			2					2	2	2	2	2	2	2		1	1	1	0	0	0		2	2	
Cutting																										
Cutting height																										
Cutting side slopes (Rock)	1:																									
Cutting side slopes (Soil)	1:																									
%Clay/Silt																										
%Sand/Gravel																										
% Rock																										
At-grade/transition																										
Excavation depth		1	1		1	1	1	1								1							1			
%Clay/Silt		20%	80%		100%	100%	100%	100%								100%							100%			
%Sand/Gravel		80%	20%		0%	0%	0%	0%								0%							0%			
%Rock		0%			0%	0%	0%	0%								0%							0%			
Additional sub-grade excavation																										
Excavation depth									0.5	0.5	0.5	0.5	0.5	0.5	0.5		0.5	0.5	0.5	0.5	0.5	0.5				
Tunnel																										
Cross-sectional area																										
Tunnel construction (D&B,TBM, Exc)																										
Assumed % overbreak																										
Clay/Silt																										
Sand/Gravel																										
Rock																										
Widening																										
Existing Road Width																										
Additional lateral excavation																										
Widening width (excl. Verge)																										
Vertical Alignment																										

Capping and sub-base																									
cuttings	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	
emb	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	
at grade	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	
Pavement (Bound)																									
Thickness	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	
% of Aggregates	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	
Material Required																									
Processed rock fill/m	14,85	21,15	17,43	24,30	21,15	24,30	21,15	5,18	5,18	5,18	5,18	12,88	21,63	16,03	16,20	6,79	6,79	6,79	2,45	4,90	2,45	2,70	3,08	3,08	
General Embankment fill/m			14,37					46,62	46,62	46,62	46,62	152,42	214,92	93,12		78,71	78,71	78,71	3,50	21,00	7,00		21,22	21,22	
Pavement /m	3,6	5,7	5,7	6,75	5,7	6,75	5,7	1,8	1,8	1,8	1,8	3,6	6,45	5,7	4,65	1,8	1,8	1,8	7,05	8,1	7,05	0,9	0,9	0,9	
Compacted Volume																									
Processed rock fill (m^3)	8955,00	31194,00	3341,25	8110,13	12477,60	6007,50	2599,50	1342,00	1342,00	1274,90	1342,00	956,40	1355,63	2087,50	4030,50	332,80	832,00	416,00	1013,10	2121,30	1350,80	1905,75	461,40	692,10	95541,15
General fill (m^3)	0,00	0,00	2155,50	0,00	0,00	0,00	0,00	9324,00	9324,00	8857,80	9324,00	9145,20	10746,00	9312,00	0,00	3148,40	7871,00	3935,50	420,00	3780,00	1120,00	0,00	2546,40	3819,60	94829,40
Total																									190370,55
Transport Bulk Volumes																									
Processed rock fill (m^3)	11479,81	39988,98	4283,30	10396,73	15995,59	7701,28	3332,41	1720,37	1720,37	1634,35	1720,37	1226,05	1737,84	2676,06	5166,88	426,63	1066,58	533,29	1298,74	2719,39	1731,65	2443,07	591,49	887,23	122478,45
General fill (m^3)	0,00	0,00	2726,49	0,00	0,00	0,00	0,00	11793,92	11793,92	11204,22	11793,92	11567,75	13592,61	11778,74	0,00	3982,41	9956,02	4978,01	531,26	4781,32	1416,69	0,00	3220,94	4831,41	119949,62
Total																									242428,0646
Total mass																									
Processed rock fill (T)	0,00	0,00	6515,44	15814,74	24331,32	11714,63	5069,03	2616,90	2616,90	2486,06	2616,90	1864,98	2643,47	4070,63	7859,48	648,96	1622,40	811,20	1975,55	4136,54	2634,06	3716,21	899,73	1349,60	108014,69
General Embankment fill (T)	0,00	0,00	4311,00	0,00	0,00	0,00	0,00	18648,00	18648,00	17715,60	18648,00	18290,40	21492,00	18624,00	0,00	6296,80	15742,00	7871,00	840,00	7560,00	2240,00	0,00	5092,80	7639,20	189658,80
Total																									297673,4925
Material Excavated																									
Rock /m	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
Granular (Sand/Gravel) /m	13,20	4,70	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
Cohesive (Clay/Silt) /m	3,30	18,80	0,00	27,00	23,50	27,00	23,50	3,00	3,00	3,00	3,00	8,50	14,75	10,75	18,00	4,50	4,50	4,50	1,75	3,50	1,75	3,00	0,00	0,00	
Burrow Volume																									
Rock (m^3)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Granular (Sand/Gravel) (m^3)	6600,00	5640,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	12240,00
Cohesive (Clay/Silt)	1650,00	22560,00	0,00	7290,00	11280,00	5400,00	2350,00	600,00	600,00	570,00	600,00	510,00	737,50	1075,00	3600,00	180,00	450,00	225,00	210,00	630,00	280,00	1650,00	0,00	0,00	62447,50
Total																									74687,5
After Swelling/Bulking																									
Rock (m^3)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Granular (Sand/Gravel) (m^3)	8250,00	7050,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	15300,00
Cohesive (Clay/Silt)	2145,00	29328,00	0,00	9477,00	14664,00	7020,00	3055,00	780,00	780,00	741,00	780,00	663,00	958,75	1397,50	4680,00	234,00	585,00	292,50	273,00	819,00	364,00	2145,00	0,00	0,00	81181,75
Total																									96481,75
Total mass																									
Rock (T)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Granular (Sand/Gravel) (T)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Cohesive (Clay/Silt)	0,00	0,00	0,00	16038,00	24816,00	11880,00	5170,00	1320,00	1320,00	1254,00	1320,00	1122,00	1622,50	2365,00	7920,00	396,00	990,00	495,00	462,00	1386,00	616,00	3630,00	0,00	0,00	84122,50
Total																									

Notes

Particular Geology

Post Glacial Clay (Clay content > 25%)

Assumptions

General Assumptions

Assume excavation of 1m for all roads at-grade

Assume embankments require 0.7m nominal processed rock for capping and sub-base (400mm capping, 300mm sub-base) [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), Trafikklass 5]

Assume at-grade construction requires 0.9m nominal processed rock for capping and sub-base (600mm capping, 300mm sub-base) [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), trafikklass 5]

Assume only sub-base required in cuttings beyond transition zone (i.e. 300mm sub-base)

Assume embankments over 4m height over clays/silts require either excavation to granular soils/rock or ground improvement. Engineering judgement to be made based on soil and depth to bedrock maps

For retaining walls/reinforced earth walls, set side slope to 0 (for both sides) or half design slope (for RW on one side only)

Assume 0% of excavated clay/silt reusable. Requires processing (i.e. sub-grade and at-grade excavation necessary to achieve adequate foundation bearing capacity)

Assumed pavement thickness of 0.3m [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), Trafikklass 5]

Assumed 85% of pavement comprises processed rock

If central reserve is paved, set hard strip to central reserve width/2

No distinction has been made between consolidated and unconsolidated in-situ soils. The mass has been determined by the average bulk density (after applying swell factors)

Assume general fill comprises granular and cohesive soils

Assume lower swelling factor for delivered material (dry/unsaturated soils)

Assume lower bulk density value for delivered material (unsaturated)

Compaction Densities obtained from Geoguide 1. Selected Compaction Density is the lesser of: Average Compaction Density and Burrow Density

Compaction Factor = Compaction Density/Loose Bulk Density. General Fill Loose Bulk Density Assumed from 50% Granular, 50% Cohesive. Used to obtain transportation volumes

Till is assumed to be reusable as general fill. In the case of Cross-connection Södertörn, till encountered is very limited. Where encountered and excavated, the till has been split into rock and cohesive with a split of 30/70.

Particular Assumptions

Entire road resurfaced for Glömstavägen widening

Summary

Excavated			Required	
Loose Rock (T)	Loose Sands and Gravels (T)	Loose Silts/Clays (T)	Loose Crushed Rock (T)	Loose General Embankment Fill (T)
0	0	84122,5	108014,69	189658,8

Haningeleden 1

		Mainline									
Road Chainage											
From		6700	6930	7000	7150	7260	7400	7690	7800	7960	8100
To		6930	7000	7150	7250	7320	7670	7800	7960	8100	8150
Length		230	70	150	100	60	270	110	160	140	50
Construction Type		Emb	Cut	Emb	Emb	Emb	Emb	Emb	Emb	Emb	Emb
Geometry											
Overall											
No of lanes		4	4	5	5	5	4	4	4	2	2
Lane width		3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Central Reserve		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0	0
Hard strip		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0
Hard shoulder		2	2	2	2	2	2	2	2	2	2
Verge		1	1	1	1	1	1	1	1	1	1
Road width (incl. verges)		23.5	23.5	27	27	27	23.5	23.5	23.5	13	13
Embankment											
Average height		1.5		1.5	5	5	5	3.5	2	2	3
Side slope	1:	2		2	2	0	2	2	2	2	2
Cutting											
Cutting height			2								
Cutting side slopes (Rock)	1:		1								
Cutting side slopes (Soil)	1:		2								
%Clay/Silt			0%								
%Sand/Gravel			100%								
% Rock			0%								
At-grade/transition											
Excavation depth											
%Clay/Silt											
%Sand/Gravel											
%Rock											
Additional sub-grade excavation											
Excavation depth							1				
Tunnel											
Cross-sectional area											
Tunnel construction (D&B,TBM, Exc)											
Assumed % overbreak											
Clay/Silt											
Sand/Gravel											
Rock											

Road Chainage									
From	8160	8340	8550	8960	9480	9800	9900	10900	11160
To	8340	8550	8880	9480	9770	9900	10840	11160	11320
Length	180	210	330	520	290	100	940	260	160
Construction Type	Emb	At-Grade	Emb	Cut	Emb	Cut	At-Grade	Emb	Cut
Geometry									
Overall									
No of lanes	2	2	2	2	2	2	2	2	2
Lane width	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Central Reserve	0	0	0	0	0	0	0	0	0
Hard strip	0	0	0	0	0	0	0	0	0
Hard shoulder	2	2	2	2	2	2	2	2	2
Verge	1	1	1	1	1	1	1	1	1
Road width (incl. verges)	13	13	13	13	13	13	13	13	13
Embankment									
Average height	2		2.5		2			3	
Side slope	2		2		2			2	
Cutting									
Cutting height				5		3			3
Cutting side slopes (Rock)				1		1			1
Cutting side slopes (Soil)				2		2			2
%Clay/Silt				0%		0%			0%
%Sand/Gravel				20%		30%			30%
% Rock				80%		70%			70%
At-grade/transition									
Excavation depth		1					1		
%Clay/Silt		80%					80%		
%Sand/Gravel		20%					20%		
%Rock		0%					0%		
Additional sub-grade excavation									
Excavation depth									
Tunnel									
Cross-sectional area									
Tunnel construction (D&B,TBM, Exc)									
Assumed % overbreak									
Clay/Silt									
Sand/Gravel									
Rock									

	Ramp A		Ramp B		Ramp C	Ramp D	Side Road (Two-lane)	Side Road + cycle path	**Total**
Road Chainage									
From	0	400	0	250	0	130	60	0	
To	400	500	250	350	320	350	700	300	
Length	400	100	250	100	320	220	640	300	
Construction Type	At-Grade	Emb	Emb	At-Grade	At-Grade	At-Grade	At-Grade	At-Grade	
Geometry									
Overall									
No of lanes	1	1	1	1	1	1	2	1	
Lane width	3.5	3.5	3.5	3.5	3.5	3.5	3	3	
Central Reserve	0	0	0	0	0	0	0	0	
Hard strip	0.5	0.5	0.5	0.5	0.5	0.5	0	0	
Hard shoulder	2	2	2	2	2	2	0	0	
Verge	0	0	0	0	0	0	0	0	
Road width (incl. verges)	6	6	6	6	6	6	6	3	
Embankment									
Average height		5	3						
Side slope		2	2						
Cutting									
Cutting height									
Cutting side slopes (Rock)									
Cutting side slopes (Soil)									
%Clay/Silt									
%Sand/Gravel									
% Rock									
At-grade/transition									
Excavation depth	1			1	1	1	1	1	
%Clay/Silt	80%			80%	80%	80%	80%	80%	
%Sand/Gravel	20%			20%	20%	20%	20%	20%	
%Rock	0%			0%	0%	0%	0%	0%	
Additional sub-grade excavation									
Excavation depth		1							
Tunnel									
Cross-sectional area									
Tunnel construction (D&B,TBM, Exc)									
Assumed % overbreak									
Clay/Silt									
Sand/Gravel									
Rock									

Widening																												
Existing Road Width																												
Additional lateral excavation																												
Widening width (excl. Verge)																												
Vertical Alignment																												
Capping and sub-base																												
cuttings	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	
emb	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	
at grade	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	
Pavement																												
Thickness	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	
% of Aggregates	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	
Material Required																												
Processed rock fill/m	17,4	7,1	19,9	19,9	18,9	17,4	17,4	17,4	10,1	10,1	10,1	11,7	10,1	3,9	10,1	3,9	11,7	10,1	3,9	5,4	5,2	5,2	5,4	5,4	5,4	5,4	2,7	
General Embankment fill/m	17,0		19,1	157,7	110,7	143,4	83,2	32,1	20,5	43,1	20,5		31,3		20,5			43,1			71,6	28,4						
Pavement /m	3,8	3,8	4,5	4,5	4,5	3,8	3,8	3,8	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	2,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	0,6	
Compacted Volume																												
Processed rock fill (m^3)	4751,8	719,6	3555,8	2370,5	1363,5	5578,2	2272,6	3305,6	1673,0	597,5	2151,0	2849,7	3943,5	3000,4	3465,5	577,0	12755,8	3107,0	923,2	2568,0	620,0	1550,0	642,0	2054,4	1412,4	4108,8	963,0	72879,75
General fill (m^3)	3914,6	0,0	2868,0	15772,0	6642,0	38709,9	9154,2	5131,2	2872,8	2156,0	3693,6	0,0	10335,6	0,0	5950,8	0,0	0,0	11211,2	0,0	0,0	7162,0	7105,0	0,0	0,0	0,0	0,0	0,0	132678,9
Total																												205558,65
Transport Bulk Volumes																												
Processed rock fill (m^3)	6091,5	922,5	4558,3	3038,8	1747,9	7150,9	2913,3	4237,6	2144,7	766,0	2757,5	3653,2	5055,3	3846,3	4442,6	739,7	16352,2	3983,0	1183,5	3292,0	794,8	1987,0	823,0	2633,6	1810,6	5267,3	1234,5	93427,79063
General fill (m^3)	4951,6	0,0	3627,7	19950,0	8401,5	48964,1	11579,1	6490,5	3633,8	2727,1	4672,0	0,0	13073,5	0,0	7527,2	0,0	0,0	14181,0	0,0	0,0	9059,2	8987,1	0,0	0,0	0,0	0,0	0,0	167825,4147
Total																												261253,2054
Total mass																												
Processed rock fill (T)	9266,0	1403,2	6933,7	4622,5	2658,8	10877,5	4431,6	6445,9	3262,4	1165,1	4194,5	5556,9	7689,8	5850,8	6757,7	1125,2	24873,8	6058,7	1800,2	5007,6	1209,0	3022,5	1251,9	4006,1	2754,2	8012,2	1877,9	142115,5125
General Embankment fill (T)	7829,2	0,0	5736,0	31544,0	13284,0	77419,8	18308,4	10262,4	5745,6	4312,0	7387,2	0,0	20671,2	0,0	11901,6	0,0	0,0	22422,4	0,0	0,0	14324,0	14210,0	0,0	0,0	0,0	0,0	0,0	265357,8
Total																												407473,3125
Material Excavated																												
Rock /m	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	68,0	0,0	31,7	0,0	0,0	31,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	
Granular (Sand/Gravel) /m	0,0	55,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,6	0,0	23,0	0,0	17,1	2,6	0,0	17,1	1,2	0,0	0,0	1,2	1,2	1,2	1,2	0,6	
Cohesive (Clay/Silt) /m	0,0	0,0	0,0	0,0	0,0	23,5	0,0	0,0	0,0	0,0	0,0	10,4	0,0	0,0	0,0	0,0	10,4	0,0	0,0	4,8	6,0	0,0	4,8	4,8	4,8	4,8	2,4	
Burrow Volume																												
Rock (m^3)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	35360,0	0,0	3171,0	0,0	0,0	5073,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	43604,6
Granular (Sand/Gravel) (m^3)	0,0	3850,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	546,0	0,0	11960,0	0,0	1710,0	2444,0	0,0	2736,0	480,0	0,0	0,0	120,0	384,0	264,0	768,0	180,0	25442
Cohesive (Clay/Silt)	0,0	0,0	0,0	0,0	0,0	6345,0	0,0	0,0	0,0	0,0	0,0	2184,0	0,0	0,0	0,0	0,0	9776,0	0,0	0,0	1920,0	600,0	0,0	480,0	1536,0	1056,0	3072,0	720,0	27689
Total																												96735,6
After Swelling/Bulking																												
Rock (m^3)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	62764,0	0,0	5628,5	0,0	0,0	9005,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	77398,165
Granular (Sand/Gravel) (m^3)	0,0	4812,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	682,5	0,0	14950,0	0,0	2137,5	3055,0	0,0	3420,0	600,0	0,0	0,0	150,0	480,0	330,0	960,0	225,0	31802,5
Cohesive (Clay/Silt)	0,0	0,0	0,0	0,0	0,0	8248,5	0,0	0,0	0,0	0,0	0,0	2839,2	0,0	0,0	0,0	0,0	12708,8	0,0	0,0	2496,0	780,0	0,0	624,0	1996,8	1372,8	3993,6	936,0	35995,7
Total																												145196,365
Total mass																												
Rock (T)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	95472,0	0,0	8561,7	0,0	0,0	13698,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	117732,42
Granular (Sand/Gravel) (T)	0,0	7074,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1003,3	0,0	21976,5	0,0	3142,1	4490,9	0,0	5027,4	882,0	0,0	0,0	220,5	705,6	485,1	1411,2	330,8	46749,675
Cohesive (Clay/Silt)	0,0	0,0	0,0	0,0	0,0	13959,0	0,0	0,0	0,0	0,0	0,0	4804,8	0,0	0,0	0,0	0,0	21507,2	0,0	0,0	4224,0	1320,0	0,0	1056,0	3379,2	2323,2	6758,4	1584,0	60915,8
Total																												225397,895

Notes

Particular Geology
Generally Clay/Silt overlying sands and gravels overlying rock

Assumptions
General Assumptions
Assume excavation of 1m for all roads at-grade
Assume embankments require 0.7m nominal processed rock for capping and sub-base (400mm capping, 300mm sub-base) [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), Trafikklass 5]
Assume at-grade construction requires 0.9m nominal processed rock for capping and sub-base (600mm capping, 300mm sub-base) [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), trafikklass 5]
Assume only sub-base required in cuttings beyond transition zone (i.e. 300mm sub-base)
Assume embankments over 4m height over clays/silts require either excavation to granular soils/rock or ground improvement. Engineering judgement to be made based on soil and depth to bedrock maps
For retaining walls/reinforced earth walls, set side slope to 0 (for both sides) or half design slope (for RW on one side only)
Assume 0% of excavated clay/silt reusable. Requires processing (i.e. sub-grade and at-grade excavation necessary to achieve adequate foundation bearing capacity)
Assumed pavement thickness of 0.3m [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), Trafikklass 5]
Assumed 85% of pavement comprises processed rock
If central reserve is paved, set hard strip to central reserve width/2
No distinction has been made between consolidated and unconsolidated in-situ soils. The mass has been determined by the average bulk density (after applying swell factors)
Assume general fill comprises granular and cohesive soils
Assume lower swelling factor for delivered material (dry/unsaturated soils)
Assume lower bulk density value for delivered material (unsaturated)
Compaction Densities obtained from Geoguide 1. Selected Compaction Density is the lesser of: Average Compaction Density and Burrow Density
Compaction Factor = Compaction Density/Loose Bulk Density. General Fill Loose Bulk Density Assumed from 50% Granular, 50% Cohesive. Used to obtain transportation volumes
Till is assumed to be reusable as general fill. In the case of Cross-connection Södertörn, till encountered is very limited. Where encountered and excavated, the till has been split into rock and cohesive with a split of 30/70.

Particular Assumptions
Embankments over 4m:
CH7150 - 7320 Possible extensive silt/clay. Rock head 5-30m deep. Likely piled embankment, or ground improvement. Assume no excavation of clay/silt.
CH7400 - 7670 0 - 3m to rock head. Assume excavation of 1m of clay/silt.

Summary

Excavated			Required	
Loose Rock (T)	Loose Sands and Gravels	Loose Silts/Clays (T)	Loose Crushed Rock (T)	Loose General Embankment Fill (T)
117732,4	46749,68	60915,8	142115,5	265357,8

Haningeleden 2-4

Road Chainage		Mainline																				**Total**
From		11550	11950	12050	13250	13500	13900	14120	14780	14900	15350	15800	16450	17250	17850	18550	19150	19320	19770	20270	20770	
To		11950	12050	13250	13500	13900	14120	14570	14900	15350	15800	16450	17250	17850	18550	19150	19320	19770	20270	20800	End	
Length		400	100	1200	250	400	220	450	120	450	450	650	800	600	700	600	170	450	500	530	KeepExisting	
Construction Type		Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening	Widening		
Geometry																						
Overall																						
No of lanes		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		
Lane width		3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333	3.33333		
Central Reserve		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Hard strip		0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75		
Hard shoulder		0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75		
Verge (assume)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Road width (incl. verges)		15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0		
Embankment																						
Average height			3		3		3							3	1.5					5		
Side slope	1:		2		2		2							2	2					2		
Cutting																						
Cutting height																						
Cutting side slopes (Rock)	1:																					
Cutting side slopes (Soil)	1:																					
%Clay/Silt																						
%Sand/Gravel																						
% Rock																						
At-grade/transition																						
Excavation depth		1		1				1	1	1	1	1	1			1	1	1	1			
%Clay/Silt		80%		60%				50%	80%	20%	70%	70%	70%			20%	70%	10%	80%			
%Sand/Gravel		20%		30%				40%	20%	80%	20%	30%	20%			20%	20%	80%	20%			
%Rock		0%		10%				10%	0%	0%	10%	0%	10%			60%	10%	10%	0%			
Additional sub-grade excavation																						
Excavation depth			0.5		0.5									0.5						0.5		
Tunnel																						
Cross-sectional area																						
Tunnel construction (D&B,TBM, Exc)																						
Assumed % overbreak																						
Clay/Silt																						
Sand/Gravel																						
Rock																						
Widening																						
Existing Road Width		8.5	11	11	8.5	8.5	8.5	8.5	8.5	11	8.5	11	8.5	8.5	8.5	8.5	8.5	11	8.5	8.5		
Additional lateral excavation		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Widening width (excl. Verge)		5.5	3.0	3.0	5.5	5.5	5.5	5.5	5.5	3.0	5.5	3.0	5.5	5.5	5.5	5.5	5.5	3.0	5.5	5.5		
Vertical Alignment		At-Grade	Emb	At-Grade	Emb	At-Grade	Emb	At-Grade	At-Grade	At-Grade	At-Grade	At-Grade	At-Grade	Emb	Emb	At-Grade	At-Grade	At-Grade	At-Grade	Emb		

Capping and sub-base																					
cuttings	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3		
emb	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7	0,7		
at grade	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9		
Pavement																					
Thickness	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3		
% of Aggregates	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%		
Material Required																					
Processed rock fill/m	5,8	3,6	3,6	6,6	5,8	3,8	5,8	5,8	3,6	5,8	3,6	5,8	6,6	3,8	5,8	5,8	3,6	5,8	6,6		
General Embankment fill/m		4,5		8,2		11,0							8,2	2,7					19,2		
Pavement /m	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9	3,9		
Compacted Volume																					
Processed rock fill (m^3)	3666,0	691,5	8298,0	2478,7	3666,0	1576,3	4124,2	1099,8	3111,7	4124,2	4494,7	7332,0	5949,0	5015,5	5499,0	1558,0	3111,7	4582,5	5254,9		75633,99
General fill (m^3)	0,0	450,0	0,0	2062,5	0,0	2420,0	0,0	0,0	0,0	0,0	0,0	0,0	4950,0	1925,0	0,0	0,0	0,0	0,0	10202,5		22009,96
Total																					97643,95
Transport Bulk Volumes																					
Processed rock fill (m^3)	4699,6	886,5	10637,6	3177,6	4699,6	2020,7	5287,1	1409,9	3989,1	5287,1	5762,0	9399,2	7626,3	6429,6	7049,4	1997,3	3989,1	5874,5	6736,5		96958,58
General fill (m^3)	0,0	569,2	0,0	2608,8	0,0	3061,1	0,0	0,0	0,0	0,0	0,0	0,0	6261,2	2434,9	0,0	0,0	0,0	0,0	12905,1		27840,38
Total																					124798,95
Total mass																					
Processed rock fill (T)	7148,7	1348,4	16181,1	4833,6	7148,7	3073,8	8042,3	2144,6	6067,9	8042,3	8764,7	14297,4	11600,5	9780,2	10723,0	3038,2	6067,9	8935,9	10247,1		147486,29
General Embankment fill (T)	0,0	900,0	0,0	4125,0	0,0	4840,0	0,0	0,0	0,0	0,0	0,0	0,0	9900,0	3850,0	0,0	0,0	0,0	0,0	20405,0		44019,92
Total																					191506,20
Material Excavated																					
Rock /m	0,0	0,0	0,3	0,0	0,0	0,0	0,5	0,0	0,0	0,5	0,0	0,5	0,0	0,0	3,3	0,5	0,3	0,0	0,0		
Granular (Sand/Gravel) /m	1,1	0,0	0,9	0,0	0,0	0,0	2,2	1,1	2,4	1,1	0,9	1,1	0,0	0,0	1,1	1,1	2,4	1,1	0,0		
Cohesive (Clay/Silt) /m	4,4	1,5	1,8	2,7	0,0	0,0	2,7	4,4	0,6	3,8	2,1	3,8	2,7	0,0	1,1	3,8	0,3	4,4	2,7		
Burrow Volume																					
Rock (m^3)	0,0	0,0	360,0	0,0	0,0	0,0	247,5	0,0	0,0	247,5	0,0	440,0	0,0	0,0	1980,0	93,5	135,0	0,0	0,0		3503,49
Granular (Sand/Gravel) (m^3)	440,0	0,0	1080,0	0,0	0,0	0,0	990,0	132,0	1080,0	495,0	585,0	880,0	0,0	0,0	660,0	187,0	1080,0	550,0	0,0		8158,98
Cohesive (Clay/Silt)	1760,0	150,0	2160,0	687,5	0,0	0,0	1237,5	528,0	270,0	1732,5	1365,0	3080,0	1650,0	0,0	660,0	654,5	135,0	2200,0	1457,5		19727,46
Total																					31389,93
After Swelling/Bulking																					
Rock (m^3)	0,0	0,0	639,0	0,0	0,0	0,0	439,3	0,0	0,0	439,3	0,0	781,0	0,0	0,0	3514,5	166,0	239,6	0,0	0,0		6218,70
Granular (Sand/Gravel) (m^3)	550,0	0,0	1350,0	0,0	0,0	0,0	1237,5	165,0	1350,0	618,7	731,2	1100,0	0,0	0,0	825,0	233,7	1350,0	687,5	0,0		10198,72
Cohesive (Clay/Silt)	2288,0	195,0	2808,0	893,7	0,0	0,0	1608,7	686,4	351,0	2252,2	1774,5	4004,0	2145,0	0,0	858,0	850,8	175,5	2860,0	1894,7		25645,70
Total																					42063,12
Total mass																					
Rock (T)	0,0	0,0	972,0	0,0	0,0	0,0	668,2	0,0	0,0	668,2	0,0	1188,0	0,0	0,0	5346,0	252,4	364,5	0,0	0,0		9459,43
Granular (Sand/Gravel) (T)	808,5	0,0	1984,5	0,0	0,0	0,0	1819,1	242,5	1984,5	909,6	1074,9	1617,0	0,0	0,0	1212,7	343,6	1984,5	1010,6	0,0		14992,12
Cohesive (Clay/Silt)	3872,0	330,0	4752,0	1512,5	0,0	0,0	2722,5	1161,6	594,0	3811,5	3003,0	6776,0	3630,0	0,0	1452,0	1439,9	297,0	4840,0	3206,5		43400,41
Total																					67851,96

Notes

Particular Geology

Geology varies along alignment. Where the road is at grade, the geology has been interpreted from soil maps. Where the road is on an embankment, nominal 0.5m excavation for possible clays/silts have been adopted where present on the geological maps.

Assumptions

General Assumptions

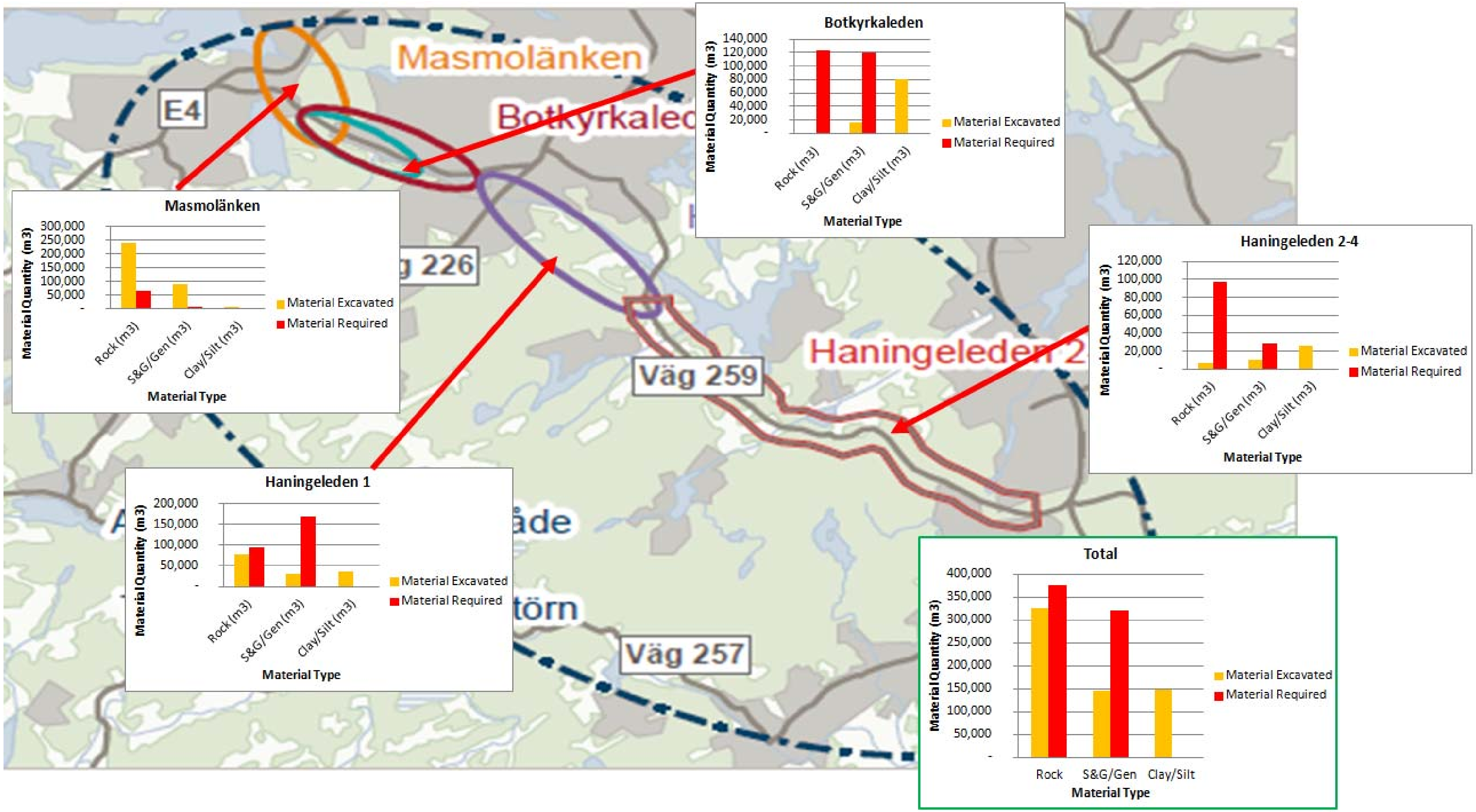
Assume excavation of 1m for all roads at-grade
Assume embankments require 0.7m nominal processed rock for capping and sub-base (400mm capping, 300mm sub-base) [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), Trafikklass 5]
Assume at-grade construction requires 0.9m nominal processed rock for capping and sub-base (600mm capping, 300mm sub-base) [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), trafikklass 5]
Assume only sub-base required in cuttings beyond transition zone (i.e. 300mm sub-base)
Assume embankments over 4m height over clays/silts require either excavation to granular soils/rock or ground improvement. Engineering judgement to be made based on soil and depth to bedrock maps
For retaining walls/reinforced earth walls, set side slope to 0 (for both sides) or half design slope (for RW on one side only)
Assume 0% of excavated clay/silt reusable. Requires processing (i.e. sub-grade and at-grade excavation necessary to achieve adequate foundation bearing capacity)
Assumed pavement thickness of 0.3m [Ref. Väg och vatten byggnader, CBM (Cementbitumenöverbyggnad), Trafikklass 5]
Assumed 85% of pavement comprises processed rock
If central reserve is paved, set hard strip to central reserve width/2
No distinction has been made between consolidated and unconsolidated in-situ soils. The mass has been determined by the average bulk density (after applying swell factors)
Assume general fill comprises granular and cohesive soils
Assume lower swelling factor for delivered material (dry/unsaturated soils)
Assume lower bulk density value for delivered material (unsaturated)
Compaction Densities obtained from Geoguide 1. Selected Compaction Density is the lesser of: Average Compaction Density and Burrow Density
Compaction Factor = Compaction Density/Loose Bulk Density. General Fill Loose Bulk Density Assumed from 50% Granular, 50% Cohesive. Used to obtain transportation volumes
Till is assumed to be reusable as general fill. In the case of Cross-connection Södertörn, till encountered is very limited. Where encountered and excavated, the till has been split into rock and cohesive with a split of 30/70.

Particular Assumptions

Additional lateral excavation length required for interlock with existing road
Widening assumes complete pavement overlay

Summary

Excavated			Required	
Loose Rock (T)	Loose Sands and Gravels (T)	Loose Silts/Clays (T)	Loose Crushed Rock (T)	Loose General Embankment Fill (T)
9459,43	14992,12	43400,41	147486,29	44019,92



Material Quantities Summary for Cross-Connection Södertörn. (Background image from Larsson, Öhman, Tyréns AB, 2015).

Appendix 7: Weighted Scoring Method for the Selection of a Strategically Located Material Bank

Weighted Scoring of Potential Strategic Material Banks

District	Latitude	Longitude	Distances Between Development Areas and Existing Material Banks (km): GK Avg	R Avg	M Avg	V Avg	JB Avg	E Avg	RF Avg	A Avg	Average Travel Distance for Business As Usual (70/30 split) (km)	Distances Between Development Areas and Strategic Material Banks (Only Improved Distances Shown): SMB1 Avg	SMB2 Avg	SMB3 Avg
Storängen	59.230805	17.990895	6.45	12.35							8.22	3.85	5.35	13.75
Huddinge Centrum	59.237500	17.979351	8.05	11.75							9.16	3.2	4.8	13.25
Skogås	59.218617	18.153501	15.25				12.5				13.325			
Trångsund	59.227840	18.130777	15.85				13.15				13.96			
Vårby Gård	59.264399	17.885881	16.5	17.05							16.665	8.05	10.05	9.15
Stuvsta	59.254619	17.995739	9.75	13.9							10.995	5.4	7	16.65
Segeltorp	59.279665	17.943897	13.6	17.4							14.74	8.8	10.5	14.4
Masmo Vårby Haga	59.248530	17.879878	14.05	14.65							14.23	6	8.45	7.25
Flemingsberg	59.217928	17.938844	10.55	8.2							8.905	1.25	2.05	10.85
Kungens Kurva	59.265882	17.912384	18.05	18.65							18.23	9.65	11.65	10
Fittja	59.250589	17.862143	15.3		15.3						15.3	6.55	8.75	5.7
Slagsta Strand	59.256902	17.854567	15.95		15.1						15.355	7.6	9.6	6.15
Between Hallunda/Fittja	59.249116	17.845380	15.45		15.1						15.205	7.55	9.7	6.3
Eriksberg (A)	59.241564	17.833453	17		12.9						14.13	8.55	10.65	3.7
Hallunda	59.244332	17.823192	17.65		13.9						15.025	9.4	11.45	4.7
Tumba C	59.200461	17.840985		11.55	13.45						12.12	8.3	6.3	5.5
Storvreten	59.193709	17.840015		11.85	13.7						12.405	8.3	6.2	5.55
Stråket Kring E4/E20 (A)	59.224037	17.828342		14.65	15.2						14.815	11.1	9.05	0.9
Tullinge C (B)	59.206476	17.907478	12.7	6.95							8.675	3.45	1.5	9.45
Riksten Företagspark	59.187613	17.923233							1.2		1.2			
Alby	59.235995	17.857164		16.8	14.15						14.945	10.3	11.15	3.4
Eriksberg (B)	59.235955	17.829505		16.5	13.4						14.33	9.85	11.05	3.25
Norra Kassmyra Grustag	59.178056	17.817196		13.9	12.4						12.85	10.35	8.4	7.9
Dalvägen	59.192345	17.824234		12.5	13.2						12.71	8.55	7.05	6.4
Stråket Kring E4/E20 (B)	59.214966	17.841400		14.45	16.85						15.17	10.85	8.9	4
Vega	59.184646	18.135827				13.7	5.65				8.065			
Handen	59.166395	18.134584				11.65	3.55				5.98			
Jordbro	59.141046	18.126000				11.7	3.6				6.03			
Tungelsta	59.101692	18.044668					9.5	3.5			5.3			
Vendelsö-Gudö	59.190928	18.212822				15.9	10.35				12.015			
Brandbergen	59.171294	18.174005				13.7	8.1				9.78			
Albyberg	59.150163	18.172173								1.3	1.3			
Brandbergens Företagsby	59.170601	18.160114				11.65	6.15				7.8			
Norrby Gärde	59.188433	18.152346				13.55	7.95				9.63			
Cross-Connection														
Masmolänken	59.250872	17.890128	14.95	15.55							15.13	6.55	8.6	7.15
Masmolänken-Botkyrkaleden	59.232019	17.917422	10.95	11.5							11.115	2.6	4.95	9.4
Haningeleden 1	59.217240	17.974371	11.05	9.45							9.93	1.8	2.5	12
Haningeleden 2-4	59.166093	18.082818	7				3.9				4.83			
										AVG	11.30			

District	Material In/Out of Developments (Tonnes): IN Total Recycled Aggregate	OUT Total Granular Arisings	Weighting In	Weighting Out	Material Bank Score (Lowest = Best): SMB1 In	SMB1 Out	SMB1 Total	SMB2 In	SMB2 Out	SMB2 Total	SMB3 In	SMB3 Out	SMB3 Total	BAU In	BAU Out	BAU Total
Storängen	238466	93994	0.102	0.014	0.393	0.055	0.448	0.546	0.077	0.623	1.403	0.197	1.600	0.839	0.118	0.957
Huddinge Centrum	119333	337453	0.051	0.052	0.163	0.165	0.328	0.245	0.247	0.492	0.676	0.683	1.359	0.468	0.472	0.940
Skogås	25483	267138	0.011	0.041	0.145	0.543	0.689	0.145	0.543	0.689	0.145	0.543	0.689	0.145	0.543	0.689
Trångsund	22469	225563	0.010	0.034	0.134	0.481	0.615	0.134	0.481	0.615	0.134	0.481	0.615	0.134	0.481	0.615
Vårby Gård	15622	140075	0.007	0.021	0.054	0.172	0.226	0.067	0.215	0.282	0.061	0.196	0.257	0.111	0.356	0.468
Stuvsta	25013	37845	0.011	0.006	0.058	0.031	0.089	0.075	0.040	0.115	0.178	0.096	0.274	0.118	0.064	0.181
Segeltorp	17818	10055	0.008	0.002	0.067	0.014	0.081	0.080	0.016	0.096	0.110	0.022	0.132	0.112	0.023	0.135
Masmo Vårby Haga	8374	21264	0.004	0.003	0.021	0.019	0.041	0.030	0.027	0.058	0.026	0.024	0.050	0.051	0.046	0.097
Flemingsberg	195071	987012	0.083	0.151	0.104	0.188	0.293	0.171	0.309	0.480	0.906	1.635	2.540	0.743	1.342	2.085
Kungens Kurva	202754	905851	0.087	0.138	0.837	1.335	2.172	1.011	1.611	2.622	0.867	1.383	2.250	1.581	2.521	4.102
Fittja	28659	64141	0.012	0.010	0.080	0.064	0.144	0.107	0.086	0.193	0.070	0.056	0.126	0.188	0.150	0.337
Slagsta Strand	33266	101386	0.014	0.015	0.108	0.118	0.226	0.137	0.149	0.285	0.088	0.095	0.183	0.219	0.238	0.456
Between Hallunda/Fittja	40497	10067	0.017	0.002	0.131	0.012	0.142	0.168	0.015	0.183	0.109	0.010	0.119	0.263	0.023	0.287
Eriksberg (A)	27798	119365	0.012	0.018	0.102	0.156	0.257	0.127	0.194	0.321	0.044	0.067	0.111	0.168	0.257	0.426
Hallunda	21386	47824	0.009	0.007	0.086	0.069	0.155	0.105	0.084	0.188	0.043	0.034	0.077	0.137	0.110	0.247
Tumba C	41661	40985	0.018	0.006	0.148	0.052	0.200	0.112	0.039	0.152	0.098	0.034	0.132	0.216	0.076	0.292
Storvreten	28861	151013	0.012	0.023	0.102	0.191	0.294	0.077	0.143	0.219	0.069	0.128	0.196	0.153	0.286	0.439
Stråket Kring E4/E20 (A)	50608	78065	0.022	0.012	0.240	0.132	0.373	0.196	0.108	0.304	0.019	0.011	0.030	0.321	0.177	0.497
Tullinge C (B)	79244	156681	0.034	0.024	0.117	0.083	0.199	0.051	0.036	0.087	0.320	0.226	0.546	0.294	0.208	0.502
Riksten Företagspark	10632	143029	0.005	0.022	0.005	0.026	0.032	0.005	0.026	0.032	0.005	0.026	0.032	0.005	0.026	0.032
Alby	5577	3078	0.002	0.000	0.025	0.005	0.029	0.027	0.005	0.032	0.008	0.002	0.010	0.036	0.007	0.043
Eriksberg (B)	2039	1451	0.001	0.000	0.009	0.002	0.011	0.010	0.002	0.012	0.003	0.001	0.004	0.013	0.003	0.016
Norra Kassmyra Grustag	31200	29496	0.013	0.005	0.138	0.047	0.185	0.112	0.038	0.150	0.105	0.036	0.141	0.172	0.058	0.229
Dalvägen	29750	91518	0.013	0.014	0.109	0.119	0.228	0.090	0.098	0.188	0.081	0.089	0.171	0.162	0.178	0.339
Stråket Kring E4/E20 (B)	7981	68565	0.003	0.010	0.037	0.114	0.151	0.030	0.093	0.124	0.014	0.042	0.056	0.052	0.159	0.211
Vega	40098	497687	0.017	0.076	0.138	0.613	0.751	0.138	0.613	0.751	0.138	0.613	0.751	0.138	0.613	0.751
Handen	13422	28729	0.006	0.004	0.034	0.026	0.061	0.034	0.026	0.061	0.034	0.026	0.061	0.034	0.026	0.061
Jordbro	12963	12845	0.006	0.002	0.033	0.012	0.045	0.033	0.012	0.045	0.033	0.012	0.045	0.033	0.012	0.045
Tungelsta	10254	11907	0.004	0.002	0.023	0.010	0.033	0.023	0.010	0.033	0.023	0.010	0.033	0.023	0.010	0.033
Vendelsö-Gudö	1774	18121	0.001	0.003	0.009	0.033	0.042	0.009	0.033	0.042	0.009	0.033	0.042	0.009	0.033	0.042
Brandbergen	8291	2187	0.004	0.000	0.035	0.003	0.038	0.035	0.003	0.038	0.035	0.003	0.038	0.035	0.003	0.038
Albyberg	70744	1663360	0.030	0.254	0.039	0.330	0.369	0.039	0.330	0.369	0.039	0.330	0.369	0.039	0.330	0.369
Brandbergens Företagsby	1093	17960	0.000	0.003	0.004	0.021	0.025	0.004	0.021	0.025	0.004	0.021	0.025	0.004	0.021	0.025
Norrby Gärde	47143	17341	0.020	0.003	0.194	0.025	0.220	0.194	0.025	0.220	0.194	0.025	0.220	0.194	0.025	0.220
Cross-Connection																
Masmolänken	0	147274	0.000	0.022	0.000	0.147	0.147	0.000	0.193	0.193	0.000	0.161	0.161	0.000	0.340	0.340
Masmolänken-Botkyrkaleden	351386	0	0.150	0.000	0.391	0.000	0.391	0.744	0.000	0.744	1.413	0.000	1.413	1.671	0.000	1.671
Haningeleden 1	294386	0	0.126	0.000	0.227	0.000	0.227	0.315	0.000	0.315	1.511	0.000	1.511	1.251	0.000	1.251
Haningeleden 2-4	176186	0	0.075	0.000	0.364	0.000	0.364	0.364	0.000	0.364	0.364	0.000	0.364	0.364	0.000	0.364
	2337302	6550325	1.000	1.000		Total	10.320			11.742			16.734			19.831
						RANK	1			2			3			4

Appendix 8: Material Flow Analysis for Strategically Located Banks

a) SMB1 Only

Material Flows into and out of Strategic Material Bank over time

Material Flows to Existing Banks under Business As Usual

District	Start	End	Material In/Out of Development (m3) – IN: Crushed Rock	IN: Sand and Gravel	IN: Total Recycled Aggregate	OUT: Rock	OUT: Sand and Gravel	OUT: Total Granular
Storängen	2016	2030	103069.9988	55567.23209	158637.2309	61792.55399	0	61792.55399
Huddinge Centrum	2016	2030	40788.07851	38972.53288	79760.61139	221843.8614	0	221843.8614
Skogås	2016	2030	1462.169326	15822.47264	17284.64196	175618.3872	0	175618.3872
Trångsund	2016	2030	1659.802535	13567.29139	15227.09392	148286.5776	0	148286.5776
Vårby Gård	2016	2030	9208.595047	1098.51883	10307.11388	49971.79414	43579.20377	93550.99791
Stuvsta	2016	2030	9771.306012	6904.449324	16675.75534	24879.42471	0	24879.42471
Segeltorp	2016	2030	7588.866278	4268.618666	11857.48494	6610.421075	0	6610.421075
Masmo Vårby Haga	2016	2030	5275.772741	237.2986258	5513.071367	811.1118872	13626.29461	14437.4065
Flemingsberg	2016	2030	51107.12913	79816.57283	130923.702	645419.3992	3569.477232	648988.8764
Kungens Kurva	2016	2030	63958.60642	71744.77767	135703.3841	555781.971	41112.92654	596894.8976
Fittja	2016	2020	13745.52143	5272.543336	19018.06476	23343.32927	19478.24339	42821.57266
Slagsta Strand	2020	2024	15106.19665	6998.036126	22104.23277	43940.49001	23501.58217	67442.07218
Between Hallunda/Fittja	2020	2024	17782.25351	9148.141509	26930.39502	6279.995626	349.8537461	6629.849372
Eriksberg (A)	2020	2024	8259.769553	10363.10212	18622.87167	76925.42874	1599.541558	78524.97029
Hallunda	2024	2028	8035.700137	6232.961425	14268.66156	29989.0722	1501.248033	31490.32024
Tumba C	2016	2020	17521.50937	10209.6105	27731.11986	24520.60311	2507.534327	27028.13744
Storvreten	2020	2024	10404.55297	8866.909825	19271.46279	81605.97669	18285.3798	99891.35649
Stråket Kring E4/E20 (A)	2024	2032	19714.63499	14027.11655	33741.75155	51320.39123	0	51320.39123
Tullinge C (B)	2024	2028	35517.26921	17154.84543	52672.11464	69415.20803	34756.57663	104171.7847
Riksten Företagspark	2016	2020	0	7232.509622	7232.509622	93704.28823	335.2232529	94039.51149
Alby	2016	2020	2377.671979	1333.333333	3711.005312	2023.809404	0	2023.809404
Eriksberg (B)	2020	2024	857.2303384	500	1357.230338	953.842897	0	953.842897
Norra Kassmyra Grustag	2028	2032	20511.11111	0	20511.11111	0	20065.00396	20065.00396
Dalvägen	2028	2032	17310.90985	2325.006368	19635.91622	18134.4738	43491.63058	61626.10439
Stråket Kring E4/E20 (B)	2024	2032	1019.141252	4375	5394.141252	45075.3292	0	45075.3292
Vega	2016	2030	1536.006929	25688.1043	27224.11123	315232.6772	12366.38596	327599.0632
Handen	2016	2030	8823.443182	0	8823.443182	11427.40924	7718.373107	19145.78235
Jordbro	2016	2030	8521.752997	0	8521.752997	272.9430796	8455.969363	8728.912443
Tungelsta	2016	2030	4502.419725	2316.81293	6819.232655	5773.826129	2125.339288	7899.165417
Vendelsö-Gudö	2016	2030	472.7007617	717.6105667	1190.311328	9911.190333	2071.592768	11982.7831
Brandbergen	2016	2030	3726.481444	1784.092145	5510.573589	855.6553189	602.5741683	1458.229487
Albyberg	2016	2030	0	48125	48125	1035574.653	59945.24219	1095519.895
Brandbergens Företagsby	2016	2030	0	743.75	743.75	11807.06874	0	11807.06874
Norrby Gärde	2016	2030	22001.60238	9303.239847	31304.84223	2450.410597	9260.807534	11711.21813
Cross-Connection	2020	2024						
Masmolänken	2020	2024	0	0	0	57925.58736	40246.38107	98171.96843
Masmolänken-	2020	2024	122478.4465	112299.6181	234778.0646	0	0	0
Haningeleden 1	2020	2024	46713.89531	151924.1647	198638.0601	0	0	0
Haningeleden 2-4	2020	2024	93849.22719	22741.01453	116590.2417	0	0	0

Strategic Material Banks SMB1 – OUT (m3)

District	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Storängen	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576
Huddinge Centrum	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317
Skogås	Flows to Existing Material Banks under Business As Usual														
Trångsund	Flows to Existing Material Banks under Business As Usual														
Vårby Gård	687	687	687	687	687	687	687	687	687	687	687	687	687	687	687
Stuvsta	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112
Segeltorp	790	790	790	790	790	790	790	790	790	790	790	790	790	790	790
Masmo Vårby Haga	368	368	368	368	368	368	368	368	368	368	368	368	368	368	368
Flemingsberg	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728
Kungens Kurva	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047
Fittja	3804	3804	3804	3804	3804	0	0	0	0	0	0	0	0	0	0
Slagsta Strand	0	0	0	0	4421	4421	4421	4421	4421	0	0	0	0	0	0
Between Hallunda/Fittja	0	0	0	0	5386	5386	5386	5386	5386	0	0	0	0	0	0
Eriksberg (A)	0	0	0	0	3725	3725	3725	3725	3725	0	0	0	0	0	0
Hallunda	0	0	0	0	0	0	0	0	2854	2854	2854	2854	2854	0	0
Tumba C	5546	5546	5546	5546	5546	0	0	0	0	0	0	0	0	0	0
Storvreten	0	0	0	0	3854	3854	3854	3854	3854	0	0	0	0	0	0
Stråket Kring E4/E20 (A)	0	0	0	0	0	0	0	0	3749	3749	3749	3749	3749	3749	3749
Tullinge C (B)	0	0	0	0	0	0	0	0	10534	10534	10534	10534	10534	0	0
Riksten Företagspark	Flows to Existing Material Banks under Business As Usual														
Alby	742	742	742	742	742	0	0	0	0	0	0	0	0	0	0
Eriksberg (B)	0	0	0	0	271	271	271	271	271	0	0	0	0	0	0
Norra Kassmyra Grustag	0	0	0	0	0	0	0	0	0	0	0	0	4102	4102	4102
Dalvägen	0	0	0	0	0	0	0	0	0	0	0	0	3927	3927	3927
Stråket Kring E4/E20 (B)	0	0	0	0	0	0	0	0	599	599	599	599	599	599	599
Vega	Flows to Existing Material Banks under Business As Usual														
Handen	Flows to Existing Material Banks under Business As Usual														
Jordbro	Flows to Existing Material Banks under Business As Usual														
Tungelsta	Flows to Existing Material Banks under Business As Usual														
Vendelsö-Gudö	Flows to Existing Material Banks under Business As Usual														
Brandbergen	Flows to Existing Material Banks under Business As Usual														
Albyberg	Flows to Existing Material Banks under Business As Usual														
Brandbergens Företagsby	Flows to Existing Material Banks under Business As Usual														
Norrby Gärde	Flows to Existing Material Banks under Business As Usual														
Cross-Connection															
Masmolänken	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Masmolänken-	0	0	0	0	46956	58695	58695	46956	23478	0	0	0	0	0	0
Haningeleden 1	0	0	0	0	39728	49660	49660	39728	23478	0	0	0	0	0	0
Haningeleden 2-4	Flows to Existing Material Banks under Business As Usual														
TOTAL	46717	46717	46717	46717	151058	162636	162636	140966	118975	54362	54362	54362	62391	49003	49003

Strategic Material Bank SMB1 – IN (m3)

District	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Storängen	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120
Huddinge Centrum	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790
Skogås	Flows to Existing Material Banks under Business As Usual														
Trångsund	Flows to Existing Material Banks under Business As Usual														
Vårby Gård	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237
Stuvsta	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659
Segeltorp	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441
Masmo Vårby Haga	962	962	962	962	962	962	962	962	962	962	962	962	962	962	962
Flemingsberg	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266
Kungens Kurva	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793
Fittja	8564	8564	8564	8564	8564	0	0	0	0	0	0	0	0	0	0
Slagsta Strand	0	0	0	0	13488	13488	13488	13488	13488	0	0	0	0	0	0
Between Hallunda/Fittja	0	0	0	0	1326	1326	1326	1326	1326	0	0	0	0	0	0
Eriksberg (A)	0	0	0	0	15705	15705	15705	15705	15705	0	0	0	0	0	0
Hallunda	0	0	0	0	0	0	0	0	6298	6298	6298	6298	6298	0	0
Tumba C	5406	5406	5406	5406	5406	0	0	0	0	0	0	0	0	0	0
Storvreten	0	0	0	0	19978	19978	19978	19978	19978	0	0	0	0	0	0
Stråket Kring E4/E20 (A)	0	0	0	0	0	0	0	0	5702	5702	5702	5702	5702	5702	5702
Tullinge C (B)	0	0	0	0	0	0	0	0	20834	20834	20834	20834	20834	0	0
Riksten Företagspark	Flows to Existing Material Banks under Business As Usual														
Alby	405	405	405	405	405	0	0	0	0	0	0	0	0	0	0
Eriksberg (B)	0	0	0	0	191	191	191	191	191	0	0	0	0	0	0
Norra Kassmyra Grustag	0	0	0	0	0	0	0	0	0	0	0	0	4013	4013	4013
Dalvägen	0	0	0	0	0	0	0	0	0	0	0	0	12325	12325	12325
Stråket Kring E4/E20 (B)	0	0	0	0	0	0	0	0	5008	5008	5008	5008	5008	5008	5008
Vega	Flows to Existing Material Banks under Business As Usual														
Handen	Flows to Existing Material Banks under Business As Usual														
Jordbro	Flows to Existing Material Banks under Business As Usual														
Tungelsta	Flows to Existing Material Banks under Business As Usual														
Vendelsö-Gudö	Flows to Existing Material Banks under Business As Usual														
Brandbergen	Flows to Existing Material Banks under Business As Usual														
Albyberg	Flows to Existing Material Banks under Business As Usual														
Brandbergens Företagsby	Flows to Existing Material Banks under Business As Usual														
Norrby Gärde	Flows to Existing Material Banks under Business As Usual														
Cross-Connection															
Masmolänken	0	0	0	0	19634	19634	19634	19634	19634	0	0	0	0	0	0
Masmolänken-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haningeleden 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haningeleden 2-4	Flows to Existing Material Banks under Business As Usual														
TOTAL	125641	125641	125641	125641	195964	181589	181589	181589	219432	149110	149110	149110	165448	138315	138315

Strategic Material Bank

SMB1	59.225155	17.944898	New Terminal in High Availability Area to the North of Flemingberg

Notes

For Building Developments: Linear Development Assumed Between Start and End Dates in line with targets in RUFS and MCPs (e.g. 600 homes per year)

Earthworks activity split for Cross-connection Södertörn 20-25-25-20-10 from 2020 to 2024

Important to check material balance in order to identify any possible shortfalls of material recycling that may require importing of material to meet demand for subgrade earthworks. This may result in increased CO2 emissions in comparison to business as usual as material will be double handled (sourced from other location, stockpiled, and reloaded for distribution)

Management of material bank should be such that the forecast base demand is met by stockpile

Strategic Material Bank SMB1 Material Flow Analysis

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
In	125641	125641	125641	125641	195964	181589	181589	181589	219432	149110	149110	149110	165448	138315	138315
Out	46717	46717	46717	46717	151058	162636	162636	140966	118975	54362	54362	54362	62391	49003	49003
Balance	78924	78924	78924	78924	44906	18953	18953	40624	100458	94748	94748	94748	103057	89312	89312
Cumulative	78924	157848	236772	315696	360602	379555	398508	439132	539590	634337	729085	823833	926890	1016202	1105514

b) SMB1 and SMB3

Material Flows into and out of Strategic Material Bank Over Time

(grey shading) Material Flows to Existing Banks under Business As Usual

Material In/Out of Development (m3)

			IN			OUT		
District	**Start**	**End**	**Crushed Rock**	**Sand and Gravel**	**Total Recycled Aggregate**	**Rock**	**Sand and Gravel**	**Total Granular**
Storängen	2016	2030	103069.999	55567.2321	158637.231	61792.554	0	61792.554
Huddinge Centrum	2016	2030	40788.0785	38972.5329	79760.6114	221843.861	0	221843.861
Skogås	2016	2030	1462.16933	15822.4726	17284.642	175618.387	0	175618.387
Trångsund	2016	2030	1659.80254	13567.2914	15227.0939	148286.578	0	148286.578
Vårby Gård	2016	2030	9208.59505	1098.51883	10307.1139	49971.7941	43579.2038	93550.9979
Stuvsta	2016	2030	9771.30601	6904.44932	16675.7553	24879.4247	0	24879.4247
Segeltorp	2016	2030	7588.86628	4268.61867	11857.4849	6610.42107	0	6610.42107
Masmo Vårby Haga	2016	2030	5275.77274	237.298626	5513.07137	811.111887	13626.2946	14437.4065
Flemingsberg	2016	2030	51107.1291	79816.5728	130923.702	645419.399	3569.47723	648988.876
Kungens Kurva	2016	2030	63958.6064	71744.7777	135703.384	555781.971	41112.9265	596894.898
Fittja	2016	2020	13745.5214	5272.54334	19018.0648	23343.3293	19478.2434	42821.5727
Slagsta Strand	2020	2024	15106.1966	6998.03613	22104.2328	43940.49	23501.5822	67442.0722
Between Hallunda/Fittja	2020	2024	17782.2535	9148.14151	26930.395	6279.99563	349.853746	6629.84937
Eriksberg (A)	2020	2024	8259.76955	10363.1021	18622.8717	76925.4287	1599.54156	78524.9703
Hallunda	2024	2028	8035.70014	6232.96142	14268.6616	29989.0722	1501.24803	31490.3202
Tumba C	2016	2020	17521.5094	10209.6105	27731.1199	24520.6031	2507.53433	27028.1374
Storvreten	2020	2024	10404.553	8866.90982	19271.4628	81605.9767	18285.3798	99891.3565
Stråket Kring E4/E20 (A)	2024	2032	19714.635	14027.1166	33741.7515	51320.3912	0	51320.3912
Tullinge C (B)	2024	2028	35517.2692	17154.8454	52672.1146	69415.208	34756.5766	104171.785
Riksten Företagspark	2016	2020	0	7232.50962	7232.50962	93704.2882	335.223253	94039.5115
Alby	2016	2020	2377.67198	1333.33333	3711.00531	2023.8094	0	2023.8094
Eriksberg (B)	2020	2024	857.230338	500	1357.23034	953.842897	0	953.842897
Norra Kassmyra Grustag	2028	2032	20511.1111	0	20511.1111	0	20065.004	20065.004
Dalvägen	2028	2032	17310.9099	2325.00637	19635.9162	18134.4738	43491.6306	61626.1044
Stråket Kring E4/E20 (B)	2024	2032	1019.14125	4375	5394.14125	45075.3292	0	45075.3292
Vega	2016	2030	1536.00693	25688.1043	27224.1112	315232.677	12366.386	327599.063
Handen	2016	2030	8823.44318	0	8823.44318	11427.4092	7718.37311	19145.7823
Jordbro	2016	2030	8521.753	0	8521.753	272.94308	8455.96936	8728.91244
Tungelsta	2016	2030	4502.41972	2316.81293	6819.23265	5773.82613	2125.33929	7899.16542
Vendelsö-Gudö	2016	2030	472.700762	717.610567	1190.31133	9911.19033	2071.59277	11982.7831
Brandbergen	2016	2030	3726.48144	1784.09215	5510.57359	855.655319	602.574168	1458.22949
Albyberg	2016	2030	0	48125	48125	1035574.65	59945.2422	1095519.89
Brandbergens Företagsby	2016	2030	0	743.75	743.75	11807.0687	0	11807.0687
Norrby Gärde	2016	2030	22001.6024	9303.23985	31304.8422	2450.4106	9260.80753	11711.2181
Cross-Connection	2020	2024						
Masmolänken	2020	2024	0	0	0	57925.5874	40246.3811	98171.9684
Masmolänken-Botkyrkaleden	2020	2024	122478.446	112299.618	234778.065	0	0	0
Haningeleden 1	2020	2024	46713.8953	151924.165	198638.06	0	0	0
Haningeleden 2-4	2020	2024	93849.2272	22741.0145	116590.242	0	0	0
								TOTAL

Strategic Material Bank SMB1 — OUT (m3)

District	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Storängen	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576	10576
Huddinge Centrum	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317	5317
Skogås	Flows to Existing Material Banks under Business As Usual														
Trångsund	Flows to Existing Material Banks under Business As Usual														
Vårby Gård	687	687	687	687	687	687	687	687	687	687	687	687	687	687	687
Stuvsta	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112
Segeltorp	790	790	790	790	790	790	790	790	790	790	790	790	790	790	790
Masmo Vårby Haga	368	368	368	368	368	368	368	368	368	368	368	368	368	368	368
Flemingsberg	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728	8728
Kungens Kurva	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047	9047
Fittja	Flows to SMB3														
Slagsta Strand	Flows to SMB3														
Between Hallunda/Fittja	Flows to SMB3														
Eriksberg (A)	Flows to SMB3														
Hallunda	Flows to SMB3														
Tumba C	Flows to SMB3														
Storvreten	Flows to SMB3														
Stråket Kring E4/E20 (A)	Flows to SMB3														
Tullinge C (B)	0	0	0	0	0	0	0	0	10534	10534	10534	10534	10534	0	0
Riksten Företagspark	Flows to Existing Material Banks under Business As Usual														
Alby	Flows to SMB3														
Eriksberg (B)	Flows to SMB3														
Norra Kassmyra Grustag	Flows to SMB3														
Dalvägen	Flows to SMB3														
Stråket Kring E4/E20 (B)	Flows to SMB3														
Vega	Flows to Existing Material Banks under Business As Usual														
Handen	Flows to Existing Material Banks under Business As Usual														
Jordbro	Flows to Existing Material Banks under Business As Usual														
Tungelsta	Flows to Existing Material Banks under Business As Usual														
Vendelsö-Gudö	Flows to Existing Material Banks under Business As Usual														
Brandbergen	Flows to Existing Material Banks under Business As Usual														
Albyberg	Flows to Existing Material Banks under Business As Usual														
Brandbergens Företagsby	Flows to Existing Material Banks under Business As Usual														
Norrby Gärde	Flows to Existing Material Banks under Business As Usual														
Cross-Connection															
Masmolänken	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Masmolänken-Botkyrkaleden	0	0	0	0	46956	58695	58695	46956	23478	0	0	0	0	0	0
Haningeleden 1	0	0	0	0	39728	49660	49660	39728	23478	0	0	0	0	0	0
Haningeleden 2-4	Flows to Existing Material Banks under Business As Usual														
TOTAL	36625	36625	36625	36625	123308	144979	144979	123308	94115	47160	47160	47160	47160	36625	36625

Strategic Material Bank SMB1 — IN (m3)

District	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Storängen	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120	4120
Huddinge Centrum	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790	14790
Skogås	Flows to Existing Material Banks under Business As Usual														
Trångsund	Flows to Existing Material Banks under Business As Usual														
Vårby Gård	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237	6237
Stuvsta	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659	1659
Segeltorp	441	441	441	441	441	441	441	441	441	441	441	441	441	441	441
Masmo Vårby Haga	962	962	962	962	962	962	962	962	962	962	962	962	962	962	962
Flemingsberg	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266	43266
Kungens Kurva	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793	39793
Fittja	Flows to SMB3														
Slagsta Strand	Flows to SMB3														
Between Hallunda/Fittja	Flows to SMB3														
Eriksberg (A)	Flows to SMB3														
Hallunda	Flows to SMB3														
Tumba C	Flows to SMB3														
Storvreten	Flows to SMB3														
Stråket Kring E4/E20 (A)	Flows to SMB3														
Tullinge C (B)	0	0	0	0	0	0	0	0	20834	20834	20834	20834	20834	0	0
Riksten Företagspark	Flows to Existing Material Banks under Business As Usual														
Alby	Flows to SMB3														
Eriksberg (B)	Flows to SMB3														
Norra Kassmyra Grustag	Flows to SMB3														
Dalvägen	Flows to SMB3														
Stråket Kring E4/E20 (B)	Flows to SMB3														
Vega	Flows to Existing Material Banks under Business As Usual														
Handen	Flows to Existing Material Banks under Business As Usual														
Jordbro	Flows to Existing Material Banks under Business As Usual														
Tungelsta	Flows to Existing Material Banks under Business As Usual														
Vendelsö-Gudö	Flows to Existing Material Banks under Business As Usual														
Brandbergen	Flows to Existing Material Banks under Business As Usual														
Albyberg	Flows to Existing Material Banks under Business As Usual														
Brandbergens Företagsby	Flows to Existing Material Banks under Business As Usual														
Norrby Gärde	Flows to Existing Material Banks under Business As Usual														
Cross-Connection															
Masmolänken	0	0	0	0	19634	19634	19634	19634	19634	0	0	0	0	0	0
Masmolänken-Botkyrkaleden	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haningeleden 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haningeleden 2-4	Flows to Existing Material Banks under Business As Usual														
TOTAL	111267	111267	111267	111267	130901	130901	130901	130901	151735	132101	132101	132101	132101	111267	111267

Strategic Material Bank

SMB1	59.225155	17.944898	New Terminal in High Availability Area to the North of Flemingberg

Notes

For Building Developments: Linear Development Assumed Between Start and End Dates in line with targets in RUFS and MCPs (e.g. 600 homes per year)
Earthworks activity split for Cross-connection Södertörn 20-25-25-20-10 from 2020 to 2024

Important to check material balance in order to identify any possible shortfalls of material recycling that may require importing of material to meet demand for subgrade earthworks. This may result in increased CO2 emissions in comparison to business as usual as material will be double handled (sourced from other location, stockpiled, and reloaded for distribution)
Management of material bank should be such that the forecast base demand is met by stockpile

Strategic Material Bank SMB1 Material Flow Analysis

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
In	111267	111267	111267	111267	130901	130901	130901	130901	151735	132101	132101	132101	132101	111267	111267
Out	36625	36625	36625	36625	123308	144979	144979	123308	94115	47160	47160	47160	47160	36625	36625
Balance	74641	74641	74641	74641	7593	-14078	-14078	7593	57620	84941	84941	84941	84941	74641	74641
Cumulative	74641	149283	223924	298565	306158	292080	278001	285594	343214	428155	513096	598038	682979	757620	832262

Material Flows into and out of Strategic Material Bank Over Time

(grey) Material Flows to Existing Banks under Business As Usual

Material In/Out of Development (m3)

District	Start	End	IN: Crushed Rock	IN: Sand and Gravel	IN: Total Recycled Aggregate	OUT: Rock	OUT: Sand and Gravel	OUT: Total Granular
Storängen	2016	2030	103069.999	55567.2321	158637.231	61792.554	0	61792.554
Huddinge Centrum	2016	2030	40788.0785	38972.5329	79760.6114	221843.861	0	221843.861
Skogås	2016	2030	1462.16933	15822.4726	17284.642	175618.387	0	175618.387
Trångsund	2016	2030	1659.80254	13567.2914	15227.0939	148286.578	0	148286.578
Vårby Gård	2016	2030	9208.59505	1098.51883	10307.1139	49971.7941	43579.2038	93550.9979
Stuvsta	2016	2030	9771.30601	6904.44932	16675.7553	24879.4247	0	24879.4247
Segeltorp	2016	2030	7588.86628	4268.61867	11857.4849	6610.42107	0	6610.42107
Masmo Vårby Haga	2016	2030	5275.77274	237.298626	5513.07137	811.111887	13626.2946	14437.4065
Flemingsberg	2016	2030	51107.1291	79816.5728	130923.702	645419.399	3569.47723	648988.876
Kungens Kurva	2016	2030	63958.6064	71744.7777	135703.384	555781.971	41112.9265	596894.898
Fittja	2016	2020	13745.5214	5272.54334	19018.0648	23343.3293	19478.2434	42821.5727
Slagsta Strand	2020	2024	15106.1966	6998.03613	22104.2328	43940.49	23501.5822	67442.0722
Between Hallunda/Fittja	2020	2024	17782.2535	9148.14151	26930.395	6279.99563	349.853746	6629.84937
Eriksberg (A)	2020	2024	8259.76955	10363.1021	18622.8717	76925.4287	1599.54156	78524.9703
Hallunda	2024	2028	8035.70014	6232.96142	14268.6616	29989.0722	1501.24803	31490.3202
Tumba C	2016	2020	17521.5094	10209.6105	27731.1199	24520.6031	2507.53433	27028.1374
Storvreten	2020	2024	10404.553	8866.90982	19271.4628	81605.9767	18285.3798	99891.3565
Stråket Kring E4/E20 (A)	2024	2032	19714.635	14027.1166	33741.7515	51320.3912	0	51320.3912
Tullinge C (B)	2024	2028	35517.2692	17154.8454	52672.1146	69415.208	34756.5766	104171.785
Riksten Företagspark	2016	2020	0	7232.50962	7232.50962	93704.2882	335.223253	94039.5115
Alby	2016	2020	2377.67198	1333.33333	3711.00531	2023.8094	0	2023.8094
Eriksberg (B)	2020	2024	857.230338	500	1357.23034	953.842897	0	953.842897
Norra Kassmyra Grustag	2028	2032	20511.1111	0	20511.1111	0	20065.004	20065.004
Dalvägen	2028	2032	17310.9099	2325.00637	19635.9162	18134.4738	43491.6306	61626.1044
Stråket Kring E4/E20 (B)	2024	2032	1019.14125	4375	5394.14125	45075.3292	0	45075.3292
Vega	2016	2030	1536.00693	25688.1043	27224.1112	315232.677	12366.386	327599.063
Handen	2016	2030	8823.44318	0	8823.44318	11427.4092	7718.37311	19145.7823
Jordbro	2016	2030	8521.753	0	8521.753	272.94308	8455.96936	8728.91244
Tungelsta	2016	2030	4502.41972	2316.81293	6819.23265	5773.82613	2125.33929	7899.16542
Vendelsö-Gudö	2016	2030	472.700762	717.610567	1190.31133	9911.19033	2071.59277	11982.7831
Brandbergen	2016	2030	3726.48144	1784.09215	5510.57359	855.655319	602.574168	1458.22949
Albyberg	2016	2030	0	48125	48125	1035574.65	59945.2422	1095519.89
Brandbergens Företagsby	2016	2030	0	743.75	743.75	11807.0687	0	11807.0687
Norrby Gärde	2016	2030	22001.6024	9303.23985	31304.8422	2450.4106	9260.80753	11711.2181
Cross-Connection	2020	2024						
Masmolänken	2020	2024	0	0	0	57925.5874	40246.3811	98171.9684
Masmolänken-Botkyrkaleden	2020	2024	122478.446	112299.618	234778.065	0	0	0
Haningeleden 1	2020	2024	46713.8953	151924.165	198638.06	0	0	0
Haningeleden 2-4	2020	2024	93849.2272	22741.0145	116590.242	0	0	0
								TOTAL

Strategic Material Bank SMB3 — OUT (m3)

District	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Storängen	Flows to SMB1														
Huddinge Centrum	Flows to SMB1														
Skogås	Flows to Existing Material Banks under Business As Usual														
Trångsund	Flows to Existing Material Banks under Business As Usual														
Vårby Gård	Flows to SMB1														
Stuvsta	Flows to SMB1														
Segeltorp	Flows to SMB1														
Masmo Vårby Haga	Flows to SMB1														
Flemingsberg	Flows to SMB1														
Kungens Kurva	Flows to SMB1														
Fittja	3804	3804	3804	3804	3804	0	0	0	0	0	0	0	0	0	0
Slagsta Strand	0	0	0	0	4421	4421	4421	4421	4421	0	0	0	0	0	0
Between Hallunda/Fittja	0	0	0	0	5386	5386	5386	5386	5386	0	0	0	0	0	0
Eriksberg (A)	0	0	0	0	3725	3725	3725	3725	3725	0	0	0	0	0	0
Hallunda	0	0	0	0	0	0	0	0	2854	2854	2854	2854	2854	0	0
Tumba C	5546	5546	5546	5546	5546	0	0	0	0	0	0	0	0	0	0
Storvreten	0	0	0	0	3854	3854	3854	3854	3854	0	0	0	0	0	0
Stråket Kring E4/E20 (A)	0	0	0	0	0	0	0	0	3749	3749	3749	3749	3749	3749	3749
Tullinge C (B)	Flows to SMB1														
Riksten Företagspark	Flows to Existing Material Banks under Business As Usual														
Alby	742	742	742	742	742	0	0	0	0	0	0	0	0	0	0
Eriksberg (B)	0	0	0	0	271	271	271	271	271	0	0	0	0	0	0
Norra Kassmyra Grustag	0	0	0	0	0	0	0	0	0	0	0	0	4102	4102	4102
Dalvägen	0	0	0	0	0	0	0	0	0	0	0	0	3927	3927	3927
Stråket Kring E4/E20 (B)	0	0	0	0	0	0	0	0	599	599	599	599	599	599	599
Vega	Flows to Existing Material Banks under Business As Usual														
Handen	Flows to Existing Material Banks under Business As Usual														
Jordbro	Flows to Existing Material Banks under Business As Usual														
Tungelsta	Flows to Existing Material Banks under Business As Usual														
Vendelsö-Gudö	Flows to Existing Material Banks under Business As Usual														
Brandbergen	Flows to Existing Material Banks under Business As Usual														
Albyberg	Flows to Existing Material Banks under Business As Usual														
Brandbergens Företagsby	Flows to Existing Material Banks under Business As Usual														
Norrby Gärde	Flows to Existing Material Banks under Business As Usual														
Cross-Connection															
Masmolänken	Flows to SMB1														
Masmolänken-Botkyrkaleden	Flows to SMB1														
Haningeleden 1	Flows to SMB1														
Haningeleden 2-4	Flows to Existing Material Banks under Business As Usual														
TOTAL	10092	10092	10092	10092	27749	17657	17657	17657	24859	7202	7202	7202	15232	12378	12378

Strategic Material Bank SMB3 — IN (m3)

District	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Storängen	Flows to SMB1														
Huddinge Centrum	Flows to SMB1														
Skogås	Flows to Existing Material Banks under Business As Usual														
Trångsund	Flows to Existing Material Banks under Business As Usual														
Vårby Gård	Flows to SMB1														
Stuvsta	Flows to SMB1														
Segeltorp	Flows to SMB1														
Masmo Vårby Haga	Flows to SMB1														
Flemingsberg	Flows to SMB1														
Kungens Kurva	Flows to SMB1														
Fittja	8564	8564	8564	8564	8564	0	0	0	0	0	0	0	0	0	0
Slagsta Strand	0	0	0	0	13488	13488	13488	13488	13488	0	0	0	0	0	0
Between Hallunda/Fittja	0	0	0	0	1326	1326	1326	1326	1326	0	0	0	0	0	0
Eriksberg (A)	0	0	0	0	15705	15705	15705	15705	15705	0	0	0	0	0	0
Hallunda	0	0	0	0	0	0	0	0	6298	6298	6298	6298	6298	0	0
Tumba C	5406	5406	5406	5406	5406	0	0	0	0	0	0	0	0	0	0
Storvreten	0	0	0	0	19978	19978	19978	19978	19978	0	0	0	0	0	0
Stråket Kring E4/E20 (A)	0	0	0	0	0	0	0	0	5702	5702	5702	5702	5702	5702	5702
Tullinge C (B)	Flows to SMB1														
Riksten Företagspark	Flows to Existing Material Banks under Business As Usual														
Alby	405	405	405	405	405	0	0	0	0	0	0	0	0	0	0
Eriksberg (B)	0	0	0	0	191	191	191	191	191	0	0	0	0	0	0
Norra Kassmyra Grustag	0	0	0	0	0	0	0	0	0	0	0	0	4013	4013	4013
Dalvägen	0	0	0	0	0	0	0	0	0	0	0	0	12325	12325	12325
Stråket Kring E4/E20 (B)	0	0	0	0	0	0	0	0	5008	5008	5008	5008	5008	5008	5008
Vega	Flows to Existing Material Banks under Business As Usual														
Handen	Flows to Existing Material Banks under Business As Usual														
Jordbro	Flows to Existing Material Banks under Business As Usual														
Tungelsta	Flows to Existing Material Banks under Business As Usual														
Vendelsö-Gudö	Flows to Existing Material Banks under Business As Usual														
Brandbergen	Flows to Existing Material Banks under Business As Usual														
Albyberg	Flows to Existing Material Banks under Business As Usual														
Brandbergens Företagsby	Flows to Existing Material Banks under Business As Usual														
Norrby Gärde	Flows to Existing Material Banks under Business As Usual														
Cross-Connection															
Masmolänken	Flows to SMB1														
Masmolänken-Botkyrkaleden	Flows to SMB1														
Haningeleden 1	Flows to SMB1														
Haningeleden 2-4	Flows to Existing Material Banks under Business As Usual														
TOTAL	14375	14375	14375	14375	65063	50688	50688	50688	67697	17009	17009	17009	33347	27049	27049

Strategic Material Bank

SMB1	59.225155	17.944898	New Terminal in High Availability Area to the North of Flemingberg

Notes

For Building Developments: Linear Development Assumed Between Start and End Dates in line with targets in RUFS and MCPs (e.g. 600 homes per ye
Earthworks activity split for Cross-connection Södertörn 20-25-25-20-10 from 2020 to 2024

Important to check material balance in order to identify any possible shortfalls of material recylcing that may require importing of material to meet demand for subgrade earthworks. This may result in increased CO2 emissions in comparison to business as usual as material will be double handled (sourced from other location, stockpiled, and reloaded for distribution)
Management of material bank should be such that the forecast base demand is met by stockpile

Strategic Material Bank SMB3 Material Flow Analysis

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
In	14375	14375	14375	14375	65063	50688	50688	50688	67697	17009	17009	17009	33347	27049	27049
Out	10092	10092	10092	10092	27749	17657	17657	17657	24859	7202	7202	7202	15232	12378	12378
Balance	4283	4283	4283	4283	37314	33031	33031	33031	42838	9807	9807	9807	18115	14671	14671
Cumulative	4283	8565	12848	17131	54445	87476	120507	153538	196376	206182	215989	225795	243911	258582	273253

Appendix 9: GHG Calculations

a) SMB1 Only

Transport Analysis for Business As Usual vs Stratetic Material Banks

Split Between Closest and Second Closest Material Bank/Quarry (Business As Usual)

% Material from closest material bank/quarry	70%
% Material from second closest material bank/quarry	30%

Inventory

HGV (Stripple 2001)

HGV Load	14	Tonnes
Fuel Consumption (Fully laden)	0.39	l/vkm
Fuel Consumption (Empty)	0.29	l/vkm
Fuel Consumption (50% laden)	0.34	l/vkm
Energy (50% laden)	11.9	MJ/vkm

GHG Emissions from Fuel Combustion (Stripple 2001)

	Unit	Flow per MJ used diesel, distribution truck	Pre-combustion addition per MJ used diesel	Total Flow, distribution truck per vkm (50% laden)
Oil	MJ	1	0.1	13.1
CO2	g	75	4	943
CH4	g	0.00005		0.000597
N2O	g	0.0016		0.0191

Global Warming Potentials IPCC (2014)

CO2 Equivalents	100yr GWP		
	IPCC (SAR)	IPCC (AR5) (2014)	
CO2	1	1	kg CO2-equ./kg
CH4	21	28	kg CO2-equ./kg
N2O	310	265	kg CO2-equ./kg

Conversion to CO2e

Direct + Indirect Emissions

Fuel	Unit	kg CO2	kg CH4	kg N2O	kg CO2e
Diesel	litres	2.7735294	0.0000018	0.0000562	2.7884653

Existing Material Bank	Latitude	Longitude
Gladökvarn (GK)	59.183970	18.006207
Riksten/Pålamalms Grustag (R)	59.156563	17.925812
Moraberg (M)	59.202006	17.668390
Vitsåvägen (V)	59.087106	18.143100
Jordbro (J)	59.159674	18.110656
Ekeby (E), Awaiting Permit	59.078907	18.041195
Riksten Friluftsstads (RF), Local Bank (C permit) for Riksten Business Park	59.192127	17.891181
Alby (A), Local Bank (C permit) for Alby	59.155783	18.166856

Strategic Material Bank

SMB1	59.225155	17.944898	New Terminal in High Availability Area to the North of Flemingberg

Notes

Average distances obtained from google maps, averaging the distances to and from material banks to development sites
Google map route selected has been checked visually to avoid smaller local roads
Stripple Vehicle Data used - Fuel combustion for 14T HGV
IPCC GWP Conversion Factors used for CO2e

			Average Distances to Existing Material Banks										Material In/Out of Developments (Tonnes)					
													IN			OUT		
District	Latitude	Longitude	GK	R	M	V	JB	E	RF	A	Average Travel Distance for Business As Usual (70/30 split) (km)	Average Distance to Strategic Material Bank SMB1 (km)	Crushed Rock	Sand and Gravel	Total Recycled Aggregate	Rock	Sand and Gravel	Total Granular Arisings
Storängen	59.230805	17.990895	6.45	12.35							8.22	3.85	156783	81684	238466	93994	0	93994
Huddinge Centrum	59.237500	17.979351	8.05	11.75							9.16	3.2	62044	57290	119333	337453	0	337453
Skogås	59.218617	18.153501	15.25				12.5				13.325		2224	23259	25483	267138	0	267138
Trångsund	59.227840	18.130777	15.85				13.15				13.96		2525	19944	22469	225563	0	225563
Vårby Gård	59.264399	17.885881	16.5	17.05							16.665	8.05	14007	1615	15622	76013	64061	140075
Stuvsta	59.254619	17.995739	9.75	13.9							10.995	5.4	14863	10150	25013	37845	0	37845
Segeltorp	59.279665	17.943897	13.6	17.4							14.74	8.8	11544	6275	17818	10055	0	10055
Masmo Vårby Haga	59.248530	17.879878	14.05	14.65							14.23	6	8025	349	8374	1234	20031	21264
Flemingsberg	59.217928	17.938844	10.55	8.2							8.905	1.25	77740	117330	195071	981765	5247	987012
Kungens Kurva	59.265882	17.912384	18.05	18.65							18.23	9.65	97289	105465	202754	845415	60436	905851
Fittja	59.250589	17.862143	15.3		15.3						15.3	6.55	20909	7751	28659	35508	28633	64141
Slagsta Strand	59.256902	17.854567	15.95		15.1						15.355	7.6	22978	10287	33266	66839	34547	101386
Between Hallunda/Fittja	59.249116	17.845380	15.45		15.1						15.205	7.55	27049	13448	40497	9553	514	10067
Eriksberg (A)	59.241564	17.833453	17		12.9						14.13	8.55	12564	15234	27798	117013	2351	119365
Hallunda	59.244332	17.823192	17.65		13.9						15.025	9.4	12223	9162	21386	45617	2207	47824
Tumba C	59.200461	17.840985		11.55	13.45						12.12	8.3	26652	15008	41661	37299	3686	40985
Storvreten	59.193709	17.840015		11.85	13.7						12.405	8.3	15827	13034	28861	124133	26880	151013
Stråket Kring E4/E20 (A)	59.224037	17.828342		14.65	15.2						14.815	11.1	29988	20620	50608	78065	0	78065
Tullinge C (B)	59.206476	17.907478	12.7	6.95							8.675	3.45	54026	25218	79244	105589	51092	156681
Riksten Företagspark	59.187613	17.923233							1.2		1.2		0	10632	10632	142536	493	143029
Alby	59.235995	17.857164		16.8	14.15						14.945	10.3	3617	1960	5577	3078	0	3078
Eriksberg (B)	59.235955	17.829505		16.5	13.4						14.33	9.85	1304	735	2039	1451	0	1451
Norra Kassmyra Grustag	59.178056	17.817196		13.9	12.4						12.85	10.35	31200	0	31200	0	29496	29496
Dalvägen	59.192345	17.824234		12.5	13.2						12.71	8.55	26332	3418	29750	27585	63933	91518
Stråket Kring E4/E20 (B)	59.214966	17.841400		14.45	16.85						15.17	10.85	1550	6431	7981	68565	0	68565
Vega	59.184646	18.135827				13.7	5.65				8.065		2336	37762	40098	479509	18179	497687
Handen	59.166395	18.134584				11.65	3.55				5.98		13422	0	13422	17383	11346	28729
Jordbro	59.141046	18.126000				11.7	3.6				6.03		12963	0	12963	415	12430	12845
Tungelsta	59.101692	18.044668					9.5	3.5			5.3		6849	3406	10254	8783	3124	11907
Vendelsö-Gudö	59.190928	18.212822				15.9	10.35				12.015		719	1055	1774	15076	3045	18121
Brandbergen	59.171294	18.174005				13.7	8.1				9.78		5668	2623	8291	1302	886	2187
Albyberg	59.150163	18.172173								1.3	1.3		0	70744	70744	1575240	88120	1663360
Brandbergens Företagsby	59.170601	18.160114				11.65	6.15				7.8		0	1093	1093	17960	0	17960
Norrby Gärde	59.188433	18.152346				13.55	7.95				9.63		33467	13676	47143	3727	13613	17341
Cross-Connection																		
Masmolänken	59.250872	17.890128	14.95	15.55							15.13	6.55	0	0	0	88112	59162	147274
Masmolänken-Botkyrkaleden	59.232019	17.917422	10.95	11.5							11.115	2.6	186305	165080	351386	0	0	0
Haningeleden 1	59.217240	17.974371	11.05	9.45							9.93	1.8	71058	223329	294386	0	0	0
Haningeleden 2-4	59.166093	18.082818	7				3.9				4.83		142757	33429	176186	0	0	0
											11.30							

Material flows IN/OUT of Development Projects — Business As Usual

District	Latitude	Longitude	Total Vehicle Kilometres (vkm) (14T HGV) IN	OUT	TOTAL	Stripple (2001) Inventory, 50% Laden IN (Litres)	50% Laden OUT (Litres)	50% Laden TOTAL (Litres)	IN CO2e (T)	OUT CO2e (T)	TOTAL CO2e (T)
Storängen	59.230805	17.990895	280028	110376	390404	95209	37528	132737	265	105	370
Huddinge Centrum	59.237500	17.979351	156156	441581	597737	53093	150137	203231	148	419	567
Skogås	59.218617	18.153501	48509	508516	557025	16493	172895	189388	46	482	528
Trångsund	59.227840	18.130777	44809	449836	494645	15235	152944	168179	42	426	469
Vårby Gård	59.264399	17.885881	37192	333478	370670	12645	113383	126028	35	316	351
Stuvsta	59.254619	17.995739	39288	59443	98731	13358	20211	33569	37	56	94
Segeltorp	59.279665	17.943897	37521	21174	58694	12757	7199	19956	36	20	56
Masmo Vårby Haga	59.248530	17.879878	17023	43228	60251	5788	14697	20485	16	41	57
Flemingsberg	59.217928	17.938844	248158	1255620	1503778	84374	426911	511285	235	1190	1426
Kungens Kurva	59.265882	17.912384	528029	2359094	2887124	179530	802092	981622	501	2237	2737
Fittja	59.250589	17.862143	62641	140194	202835	21298	47666	68964	59	133	192
Slagsta Strand	59.256902	17.854567	72970	222398	295369	24810	75615	100425	69	211	280
Between Hallunda/Fittja	59.249116	17.845380	87965	21867	109832	29908	7435	37343	83	21	104
Eriksberg (A)	59.241564	17.833453	56112	240946	297058	19078	81922	101000	53	228	282
Hallunda	59.244332	17.823192	45903	102651	148554	15607	34901	50508	44	97	141
Tumba C	59.200461	17.840985	72132	70963	143095	24525	24127	48652	68	67	136
Storvreten	59.193709	17.840015	51146	267616	318762	17390	90989	108379	48	254	302
Stråket Kring E4/E20 (A)	59.224037	17.828342	107109	165219	272328	36417	56174	92591	102	157	258
Tullinge C (B)	59.206476	17.907478	98206	194173	292379	33390	66019	99409	93	184	277
Riksten Företagspark	59.187613	17.923233	1823	24519	26342	620	8337	8956	2	23	25
Alby	59.235995	17.857164	11906	6573	18479	4048	2235	6283	11	6	18
Eriksberg (B)	59.235955	17.829505	4174	2970	7144	1419	1010	2429	4	3	7
Norra Kassmyra Grustag	59.178056	17.817196	57274	54145	111420	19473	18409	37883	54	51	106
Dalvägen	59.192345	17.824234	54017	166170	220187	18366	56498	74864	51	158	209
Stråket Kring E4/E20 (B)	59.214966	17.841400	17297	148591	165888	5881	50521	56402	16	141	157
Vega	59.184646	18.135827	46199	573407	619606	15708	194958	210666	44	544	587
Handen	59.166395	18.134584	11466	24542	36008	3898	8344	12243	11	23	34
Jordbro	59.141046	18.126000	11166	11065	22232	3797	3762	7559	11	10	21
Tungelsta	59.101692	18.044668	7764	9015	16779	2640	3065	5705	7	9	16
Vendelsö-Gudö	59.190928	18.212822	3045	31104	34149	1035	10575	11611	3	29	32
Brandbergen	59.171294	18.174005	11584	3056	14640	3938	1039	4978	11	3	14
Albyberg	59.150163	18.172173	13138	308910	322048	4467	105029	109496	12	293	305
Brandbergens Företagsby	59.170601	18.160114	1218	20013	21231	414	6804	7219	1	19	20
Norrby Gärde	59.188433	18.152346	64855	23856	88711	22051	8111	30162	61	23	84
Cross-Connection											
Masmolänken	59.250872	17.890128	0	318323	318323	0	108230	108230	0	302	302
Masmolänken-Botkyrkaleden	59.232019	17.917422	557950	0	557950	189703	0	189703	529	0	529
Haningeleden 1	59.217240	17.974371	417608	0	417608	141987	0	141987	396	0	396
Haningeleden 2-4	59.166093	18.082818	121568	0	121568	41333	0	41333	115	0	115
									3323	8281	11604

Material flows IN/OUT of Development Projects — Strategic Material Bank SMB1

District	Total Vehicle Kilometres (vkm) (14T HGV) IN	OUT	TOTAL	Stripple (2001) Inventory, 50% Laden IN (Litres)	50% Laden OUT (Litres)	50% Laden TOTAL (Litres)	IN CO2e (T)	OUT CO2e (T)	TOTAL CO2e (T)
Storängen	131157	51697	182853	44593	17577	62170	124	49	173
Huddinge Centrum	54552	154264	208817	18548	52450	70998	52	146	198
Skogås	48509	508516	557025	16493	172895	189388	46	482	528
Trångsund	44809	449836	494645	15235	152944	168179	42	426	469
Vårby Gård	17966	161086	179052	6108	54769	60878	17	153	170
Stuvsta	19296	29195	48490	6561	9926	16487	18	28	46
Segeltorp	22400	12641	35041	7616	4298	11914	21	12	33
Masmo Vårby Haga	7178	18227	25404	2440	6197	8637	7	17	24
Flemingsberg	34834	176252	211086	11844	59926	71769	33	167	200
Kungens Kurva	279511	1248780	1528291	95034	424585	519619	265	1184	1449
Fittja	26817	60018	86835	9118	20406	29524	25	57	82
Slagsta Strand	36117	110077	146194	12280	37426	49706	34	104	139
Between Hallunda/Fittja	43679	10858	54537	14851	3692	18542	41	10	52
Eriksberg (A)	33953	145795	179749	11544	49570	61115	32	138	170
Hallunda	28718	64221	92939	9764	21835	31599	27	61	88
Tumba C	49398	48597	97994	16795	16523	33318	47	46	93
Storvreten	34221	179058	213279	11635	60880	72515	32	170	202
Stråket Kring E4/E20 (A)	80250	123789	204039	27285	42088	69373	76	117	193
Tullinge C (B)	39056	77222	116278	13279	26255	39534	37	73	110
Riksten Företagspark	1823	24519	26342	620	8337	8956	2	23	25
Alby	8206	4530	12736	2790	1540	4330	8	4	12
Eriksberg (B)	2869	2042	4911	975	694	1670	3	2	5
Norra Kassmyra Grustag	46131	43611	89743	15685	14828	30513	44	41	85
Dalvägen	36337	111782	148119	12355	38006	50361	34	106	140
Stråket Kring E4/E20 (B)	12371	106276	118648	4206	36134	40340	12	101	112
Vega	46199	573407	619606	15708	194958	210666	44	544	587
Handen	11466	24542	36008	3898	8344	12243	11	23	34
Jordbro	11166	11065	22232	3797	3762	7559	11	10	21
Tungelsta	7764	9015	16779	2640	3065	5705	7	9	16
Vendelsö-Gudö	3045	31104	34149	1035	10575	11611	3	29	32
Brandbergen	11584	3056	14640	3938	1039	4978	11	3	14
Albyberg	13138	308910	322048	4467	105029	109496	12	293	305
Brandbergens Företagsby	1218	20013	21231	414	6804	7219	1	19	20
Norrby Gärde	64855	23856	88711	22051	8111	30162	61	23	84
Cross-Connection									
Masmolänken	0	137807	137807	0	46854	46854	0	131	131
Masmolänken-Botkyrkaleden	130515	0	130515	44375	0	44375	124	0	124
Haningeleden 1	75699	0	75699	25738	0	25738	72	0	72
Haningeleden 2-4	121568	0	121568	41333	0	41333	115	0	115
							1553	4803	6356

CO2e Reduction	IN	OUT	TOTAL
	1770	3478	5248
	53%	42%	45%

b) SMB1 and SMB3

Transport Analysis for Business As Usual vs Stratetic Material Banks

Split Between Closest and Second Closest Material Bank/Quarry (Business As Usual)

% Material from closest material bank/quarry	70%
% Material from second closest material bank/quarry	30%

Inventory

HGV	(Stripple 2001)	
HGV Load	14	Tonnes
Fuel Consumption (Fully laden)	0.39	l/vkm
Fuel Consumption (Empty)	0.29	l/vkm
Fuel Consumption (50% laden)	0.34	l/vkm
Energy (50% laden)	11.9	MJ/vkm

GHG Emissions from Fuel Combustion (Stripple 2001)

	Unit	Flow per MJ used diesel, distribution truck	Pre-combustion addition per MJ used diesel	Total Flow, distribution truck per vkm (50% laden)
Oil	MJ	1	0.1	13.1
CO2	g	75	4	943
CH4	g	0.00005		0.000597
N2O	g	0.0016		0.0191

Global Warming Potentials IPCC (2014)

CO2 Equivalents	100yr GWP		
	IPCC (SAR)	IPCC (AR5) (2014)	
CO2	1	1	kg CO2-equ./kg
CH4	21	28	kg CO2-equ./kg
N2O	310	265	kg CO2-equ./kg

Conversion to CO2e

Direct + Indirect Emissions

Fuel	Unit	kg CO2	kg CH4	kg N2O	kg CO2e
Diesel	litres	2.7735294	0.0000018	0.0000562	2.7884653

Existing Material Bank	Latitude	Longitude
Gladökvarn (GK)	59.183970	18.006207
Riksten/Pålamalms Grustag (R)	59.156563	17.925812
Moraberg (M)	59.202006	17.668390
Vitsåvägen (V)	59.087106	18.143100
Jordbro (J)	59.159674	18.110656
Ekeby (E), Awaiting Permit	59.078907	18.041195
Riksten Friluftsstads (RF), Local Bank (C permit) for Riksten Business Park	59.192127	17.891181
Alby (A), Local Bank (C permit) for Alby	59.155783	18.166856

Strategic Material Banks

SMB1	59.225155	17.944898	New Terminal in High Availability Area to the North of Flemingberg
SMB3	59.225141	17.837775	Material Bank in Moderate Availability Area along Hågelbyvägen in North Botkyrka

Notes

Average distances obtained from google maps, averaging the distances to and from material banks to development sites
Google map route selected has been checked visually to avoid smaller local roads
Stripple Vehicle Data used - Fuel combustion for 14T HGV
IPCC GWP Conversion Factors used for CO2e

			Average Distances to Existing Material Banks												Material In/Out of Developments (Tonnes)					
															IN			OUT		
District	Latitude	Longitude	GK	R	M	V	JB	E	RF	A	Average Travel Distance for Business As Usual (70/30 split) (km)	Average Distance to Strategic Material Bank SMB1 (km)	Average Distance to Strategic Material Bank SMB3 (km)	Closest Material Bank	Crushed Rock	Sand and Gravel	Total Recycled Aggregate	Rock	Sand and Gravel	Total Granular Arisings
Storängen	59.230805	17.990895	6.45	12.35							8.22	3.85	13.75	SMB1	156783	81684	238466	93994	0	93994
Huddinge Centrum	59.237500	17.979351	8.05	11.75							9.16	3.2	13.25	SMB1	62044	57290	119333	337453	0	337453
Skogås	59.218617	18.153501	15.25				12.5				13.325			BAU	2224	23259	25483	267138	0	267138
Trångsund	59.227840	18.130777	15.85				13.15				13.96			BAU	2525	19944	22469	225563	0	225563
Vårby Gård	59.264399	17.885881	16.5	17.05							16.665	8.05	9.15	SMB1	14007	1615	15622	76013	64061	140075
Stuvsta	59.254619	17.995739	9.75	13.9							10.995	5.4	16.65	SMB1	14863	10150	25013	37845	0	37845
Segeltorp	59.279665	17.943897	13.6	17.4							14.74	8.8	14.4	SMB1	11544	6275	17818	10055	0	10055
Masmo Vårby Haga	59.248530	17.879878	14.05	14.65							14.23	6	7.25	SMB1	8025	349	8374	1234	20031	21264
Flemingsberg	59.217928	17.938844	10.55	8.2							8.905	1.25	10.85	SMB1	77740	117330	195071	981765	5247	987012
Kungens Kurva	59.265882	17.912384	18.05	18.65							18.23	9.65	10	SMB1	97289	105465	202754	845415	60436	905851
Fittja	59.250589	17.862143	15.3		15.3						15.3	6.55	5.7	SMB3	20909	7751	28659	35508	28633	64141
Slagsta Strand	59.256902	17.854567	15.95		15.1						15.355	7.6	6.15	SMB3	22978	10287	33266	66839	34547	101386
Between Hallunda/Fittja	59.249116	17.845380	15.45		15.1						15.205	7.55	6.3	SMB3	27049	13448	40497	9553	514	10067
Eriksberg (A)	59.241564	17.833453	17		12.9						14.13	8.55	3.7	SMB3	12564	15234	27798	117013	2351	119365
Hallunda	59.244332	17.823192	17.65		13.9						15.025	9.4	4.7	SMB3	12223	9162	21386	45617	2207	47824
Tumba C	59.200461	17.840985		11.55	13.45						12.12	8.3	5.5	SMB3	26652	15008	41661	37299	3686	40985
Storvreten	59.193709	17.840015		11.85	13.7						12.405	8.3	5.55	SMB3	15827	13034	28861	124133	26880	151013
Stråket Kring E4/E20 (A)	59.224037	17.828342		14.65	15.2						14.815	11.1	0.9	SMB3	29988	20620	50608	78065	0	78065
Tullinge C (B)	59.206476	17.907478	12.7	6.95							8.675	3.45	9.45	SMB1	54026	25218	79244	105589	51092	156681
Riksten Företagspark	59.187613	17.923233							1.2		1.2			BAU	0	10632	10632	142536	493	143029
Alby	59.235995	17.857164		16.8	14.15						14.945	10.3	3.4	SMB3	3617	1960	5577	3078	0	3078
Eriksberg (B)	59.235955	17.829505		16.5	13.4						14.33	9.85	3.25	SMB3	1304	735	2039	1451	0	1451
Norra Kassmyra Grustag	59.178056	17.817196		13.9	12.4						12.85	10.35	7.9	SMB3	31200	0	31200	0	29496	29496
Dalvägen	59.192345	17.824234		12.5	13.2						12.71	8.55	6.4	SMB3	26332	3418	29750	27585	63933	91518
Stråket Kring E4/E20 (B)	59.214966	17.841400		14.45	16.85						15.17	10.85	4	SMB3	1550	6431	7981	68565	0	68565
Vega	59.184646	18.135827				13.7	5.65				8.065			BAU	2336	37762	40098	479509	18179	497687
Handen	59.166395	18.134584				11.65	3.55				5.98			BAU	13422	0	13422	17383	11346	28729
Jordbro	59.141046	18.126000				11.7	3.6				6.03			BAU	12963	0	12963	415	12430	12845
Tungelsta	59.101692	18.044668					9.5	3.5			5.3			BAU	6849	3406	10254	8783	3124	11907
Vendelsö-Gudö	59.190928	18.212822				15.9	10.35				12.015			BAU	719	1055	1774	15076	3045	18121
Brandbergen	59.171294	18.174005				13.7	8.1				9.78			BAU	5668	2623	8291	1302	886	2187
Albyberg	59.150163	18.172173								1.3	1.3			BAU	0	70744	70744	1575240	88120	1663360
Brandbergens Företagsby	59.170601	18.160114				11.65	6.15				7.8			BAU	0	1093	1093	17960	0	17960
Norrby Gärde	59.188433	18.152346				13.55	7.95				9.63			BAU	33467	13676	47143	3727	13613	17341
Cross-Connection														BAU						
Masmolänken	59.250872	17.890128	14.95	15.55							15.13	6.55	7.15	SMB1	0	0	0	88112	59162	147274
Masmolänken-Botkyrkaleden	59.232019	17.917422	10.95	11.5							11.115	2.6	9.4	SMB1	186305	165080	351386	0	0	0
Haningeleden 1	59.217240	17.974371	11.05	9.45							9.93	1.8	12	SMB1	71058	223329	294386	0	0	0
Haningeleden 2-4	59.166093	18.082818	7				3.9				4.83			BAU	142757	33429	176186	0	0	0
											11.30									

Material flows IN/OUT of Development Projects — Business As Usual

District	Latitude	Longitude	Total Vehicle Kilometres (vkm) (14T HGV) IN	Total Vehicle Kilometres (vkm) (14T HGV) OUT	Total Vehicle Kilometres (vkm) (14T HGV) TOTAL	Stripple (2001) Inventory 50% Laden IN (Litres)	50% Laden OUT (Litres)	50% Laden TOTAL (Litres)	IN CO2e (T)	OUT CO2e (T)	TOTAL CO2e (T)
Storängen	59.230805	17.990895	280028	110376	390404	95209	37528	132737	265	105	370
Huddinge Centrum	59.237500	17.979351	156156	441581	597737	53093	150137	203231	148	419	567
Skogås	59.218617	18.153501	48509	508516	557025	16493	172895	189388	46	482	528
Trångsund	59.227840	18.130777	44809	449836	494645	15235	152944	168179	42	426	469
Vårby Gård	59.264399	17.885881	37192	333478	370670	12645	113383	126028	35	316	351
Stuvsta	59.254619	17.995739	39288	59443	98731	13358	20211	33569	37	56	94
Segeltorp	59.279665	17.943897	37521	21174	58694	12757	7199	19956	36	20	56
Masmo Vårby Haga	59.248530	17.879878	17023	43228	60251	5788	14697	20485	16	41	57
Flemingsberg	59.217928	17.938844	248158	1255620	1503778	84374	426911	511285	235	1190	1426
Kungens Kurva	59.265882	17.912384	528029	2359094	2887124	179530	802092	981622	501	2237	2737
Fittja	59.250589	17.862143	62641	140194	202835	21298	47666	68964	59	133	192
Slagsta Strand	59.256902	17.854567	72970	222398	295369	24810	75615	100425	69	211	280
Between Hallunda/Fittja	59.249116	17.845380	87965	21867	109832	29908	7435	37343	83	21	104
Eriksberg (A)	59.241564	17.833453	56112	240946	297058	19078	81922	101000	53	228	282
Hallunda	59.244332	17.823192	45903	102651	148554	15607	34901	50508	44	97	141
Tumba C	59.200461	17.840985	72132	70963	143095	24525	24127	48652	68	67	136
Storvreten	59.193709	17.840015	51146	267616	318762	17390	90989	108379	48	254	302
Stråket Kring E4/E20 (A)	59.224037	17.828342	107109	165219	272328	36417	56174	92591	102	157	258
Tullinge C (B)	59.206476	17.907478	98206	194173	292379	33390	66019	99409	93	184	277
Riksten Företagspark	59.187613	17.923233	1823	24519	26342	620	8337	8956	2	23	25
Alby	59.235995	17.857164	11906	6573	18479	4048	2235	6283	11	6	18
Eriksberg (B)	59.235955	17.829505	4174	2970	7144	1419	1010	2429	4	3	7
Norra Kassmyra Grustag	59.178056	17.817196	57274	54145	111420	19473	18409	37883	54	51	106
Dalvägen	59.192345	17.824234	54017	166170	220187	18366	56498	74864	51	158	209
Stråket Kring E4/E20 (B)	59.214966	17.841400	17297	148591	165888	5881	50521	56402	16	141	157
Vega	59.184646	18.135827	46199	573407	619606	15708	194958	210666	44	544	587
Handen	59.166395	18.134584	11466	24542	36008	3898	8344	12243	11	23	34
Jordbro	59.141046	18.126000	11166	11065	22232	3797	3762	7559	11	10	21
Tungelsta	59.101692	18.044668	7764	9015	16779	2640	3065	5705	7	9	16
Vendelsö-Gudö	59.190928	18.212822	3045	31104	34149	1035	10575	11611	3	29	32
Brandbergen	59.171294	18.174005	11584	3056	14640	3938	1039	4978	11	3	14
Albyberg	59.150163	18.172173	13138	308910	322048	4467	105029	109496	12	293	305
Brandbergens Företagsby	59.170601	18.160114	1218	20013	21231	414	6804	7219	1	19	20
Norrby Gärde	59.188433	18.152346	64855	23856	88711	22051	8111	30162	61	23	84
Cross-Connection											
Masmolänken	59.250872	17.890128	0	318323	318323	0	108230	108230	0	302	302
Masmolänken-	59.232019	17.917422	557950	0	557950	189703	0	189703	529	0	529
Haningeleden 1	59.217240	17.974371	417608	0	417608	141987	0	141987	396	0	396
Haningeleden 2-4	59.166093	18.082818	121568	0	121568	41333	0	41333	115	0	115
									3323	8281	11604

Material flows IN/OUT of Development Projects — Strategic Material Banks SMB1 and SMB3

District	Total Vehicle Kilometres (vkm) (14T HGV) IN	Total Vehicle Kilometres (vkm) (14T HGV) OUT	Total Vehicle Kilometres (vkm) (14T HGV) TOTAL	Stripple (2001) Inventory 50% Laden IN (Litres)	50% Laden OUT (Litres)	50% Laden TOTAL (Litres)	IN CO2e (T)	OUT CO2e (T)	TOTAL CO2e (T)
Storängen	131157	51697	182853	44593	17577	62170	124	49	173
Huddinge Centrum	54552	154264	208817	18548	52450	70998	52	146	198
Skogås	48509	508516	557025	16493	172895	189388	46	482	528
Trångsund	44809	449836	494645	15235	152944	168179	42	426	469
Vårby Gård	17966	161086	179052	6108	54769	60878	17	153	170
Stuvsta	19296	29195	48490	6561	9926	16487	18	28	46
Segeltorp	22400	12641	35041	7616	4298	11914	21	12	33
Masmo Vårby Haga	7178	18227	25404	2440	6197	8637	7	17	24
Flemingsberg	34834	176252	211086	11844	59926	71769	33	167	200
Kungens Kurva	279511	1248780	1528291	95034	424585	519619	265	1184	1449
Fittja	23337	52229	75566	7935	17758	25692	22	50	72
Slagsta Strand	29226	89075	118301	9937	30286	40222	28	84	112
Between Hallunda/Fittja	36447	9060	45507	12392	3080	15473	35	9	43
Eriksberg (A)	14693	63093	77786	4996	21452	26447	14	60	74
Hallunda	14359	32110	46469	4882	10918	15800	14	30	44
Tumba C	32733	32203	64936	11129	10949	22078	31	31	62
Storvreten	22883	119731	142614	7780	40709	48489	22	114	135
Stråket Kring E4/E20 (A)	6507	10037	16544	2212	3413	5625	6	10	16
Tullinge C (B)	39056	77222	116278	13279	26255	39534	37	73	110
Riksten Företagspark	1823	24519	26342	620	8337	8956	2	23	25
Alby	2709	1495	4204	921	508	1429	3	1	4
Eriksberg (B)	947	674	1620	322	229	551	1	1	2
Norra Kassmyra Grustag	35211	33288	68499	11972	11318	23290	33	32	65
Dalvägen	27200	83673	110873	9248	28449	37697	26	79	105
Stråket Kring E4/E20 (B)	4561	39180	43741	1551	13321	14872	4	37	41
Vega	46199	573407	619606	15708	194958	210666	44	544	587
Handen	11466	24542	36008	3898	8344	12243	11	23	34
Jordbro	11166	11065	22232	3797	3762	7559	11	10	21
Tungelsta	7764	9015	16779	2640	3065	5705	7	9	16
Vendelsö-Gudö	3045	31104	34149	1035	10575	11611	3	29	32
Brandbergen	11584	3056	14640	3938	1039	4978	11	3	14
Albyberg	13138	308910	322048	4467	105029	109496	12	293	305
Brandbergens Företagsby	1218	20013	21231	414	6804	7219	1	19	20
Norrby Gärde	64855	23856	88711	22051	8111	30162	61	23	84
Cross-Connection									
Masmolänken	0	137807	137807	0	46854	46854	0	131	131
Masmolänken-	130515	0	130515	44375	0	44375	124	0	124
Haningeleden 1	75699	0	75699	25738	0	25738	72	0	72
Haningeleden 2-4	121568	0	121568	41333	0	41333	115	0	115
							1375	4381	5756

CO2e Reduction	IN	OUT	TOTAL
	1948	3900	5848
	59%	47%	50%

[End]

Mark is a Chartered Engineer with over 10 years experience specialising in earthworks and geotechnical engineering and aspires to raise awareness and contribute significantly towards sustainability in the construction industry throughout his future endeavours.

HALMSTAD
UNIVERSITY

PO Box 823, SE-301 18 Halmstad
Phone: +35 46 16 71 00
E-mail: registrator@hh.se
www.hh.se