PROCEDURES OF THE IMPLEMENTATIONS

The Kruunusillat project assessment of overall sustainability

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Contents

1 Introduction

1.1 The Kruunusillat project

Helsinki is planning a major transport connection which, if implemented, connects the Kruunuvuo to the metropolitan city. The future public transport connection will have an impact on the entire public transport system in the capital region: the link makes the suburb of the Kruunu Mountains part of the metropolitan area and significantly reduces travel time.

The Kruunusillat project consists of the public transport service between the central Helsinki area and Laajasalo andthe arrangements for its construction and operation (Figure 1). In addition to the tramway,the same work includes pedestrians and cycle paths. According to forecasts, the tram connection would be used by approximately 23 000 passengers every day after the completion of the Kruunu Mountain and fishing port. In the currentsituation, the distance from the Kruunu Mountain to the city centre of Helsinki is approximately 12 km. The Kruunu Mountain sea area is separated from the centre by the area of the Kruunu estuary, beyond which it would considerably shorten the distance to the centre. Theproject will also bring about a modest improvement in transport connections with the High Island.

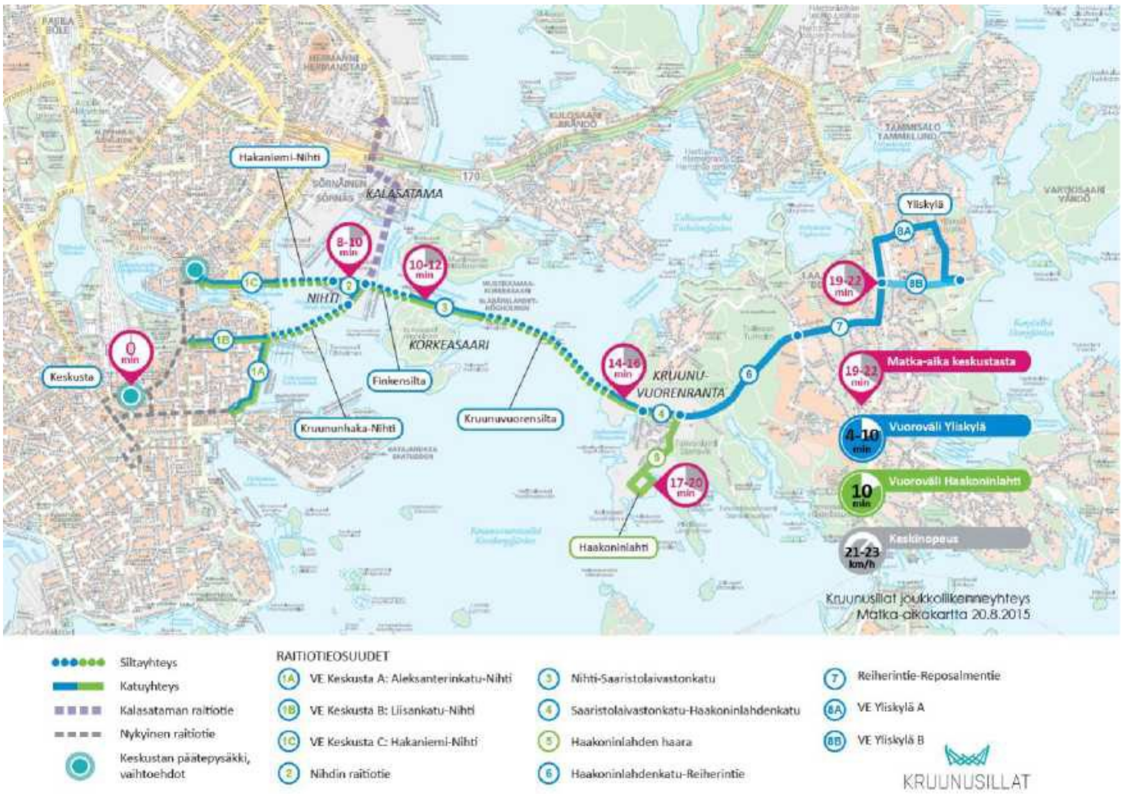

Figure 1 The public transport link 'Kruunusillat' comprises the public transport link between the central area of Helsinkiand Laajasalo and the arrangements for its construction and operation;

The preparation of the project design for the Kruunusillat project is ongoing. The aim of the-project design is to improve the management of the cohesiveness of the separate assignments forthe Cruunus Sites by describing the different stages of the process through the project and anticipating the necessary steps for implementation. The project design serves as asupport and tool for the Helsinki City of Helsinki's decision-making bodies. The aim is to start the first construction phases by 2018 at the latest and to open the portfolio to transport by 2024. The implementation of the project still requires a decision of the City Council. The decision on the Kruu- Nucsillat project can now be taken at the earliest in spring 2016. The decision on the Hanasaari power plant operation has significant implications for the Kruunusillat project. It is not possible to take a project decision on the rye until the decision on the power operation of the Hanasaari is taken.

1.2 Background and purpose of the study

This study assesses the environmental, economic and socio-cultural sustainability of the Kruunusillat project. For project design purposes, the study will provide information on the factors affecting the sustainability ofthe project and on ways to improve overall sustainability, including in the further design, construction, operation and maintenance of the project.

Overall sustainability and life-cycle impacts have been identified from the outset as important-aspects that need to be taken into account in the design and decision-making of the Kruunusillat project. Helsinki City Council decided to prioritise the implementation of the Kruunusillat project in autumn 2013. Helsinki wants to favour sustainable modes of transport such as rail and to increase the level of servicefor domestic transport. An international competition for the design of cartons sought a solution that is environmentally sustainable in a singularlydemanding environment. Life-cycle and air events were also widely present during the bridge competition. Each competition proposal included material balance reporting, which led to the calculation of material use-based carbon and footprints for all 11 bridge proposals. The carbon footprint of the winning Gemma Regalis was the second lowest among the presents involved in thebone.

An environmental impact assessment report was completed in 2014 for the rail-implementation options in the Broadcasting House. The sustainability and life-cycle perspective of the project was addressed in the evaluation report in very general terms due to the diversity of options. The need for further consideration of the life-cycle perspective and overall sustainability was highlighted in some opinions on the evaluation report.

1.3 Guidance and implementation of work

The supervision of the work was carried out by a steering group led by project manager Ville Alajoki, consisting of Juha Sorvali from the street and park department of the City of Helsinki and Sito Oy, Sakari Grönlund and Ari Savolainen. The work was carried out by Ramboll Finland Oyas project manager Riina Känkänen and by Arto Ruotsalais (land use), Ilkka Vilonen (bridge planning), Veera Sevander (environmental classifications), Jukka Lahtinpage (structures), Ka lervoMattila (maintenance), Jukka Räsänen (mobility and transport), Päivi Paavilainen (huleve-det), Juha Forsman (geoplanning) and Tommy Nyman (street planning).

The project organised an expert workshop on 23 September with 19 participants (Table 1). The workshop commented on the assessment of the impacts of climate change and on the roads of preparedness measures. Consideration was also given to the factors affecting the overall sustainability and resource efficiency of the project and ways to improve these in the design, mobility and maintenance of the structures. The questions of teamwork in relation to the assessment of the overall sustainabilityof the project were: What factors affect the overall sustainability of the project? What criteria/meters should be used to assess the overall durability? How can the overall sustainability ofthe project be further improved? The work of the workshops was used to define the elements of the overall sustainability of the project.

Table 1 Participants in the project expert workshop (23 September 2015)

Name	**Organisation**
Ville Alajoki	HKR
Annukka Eriksson	HKR
Sakari Grönlund	Binding
Juha Korhonen	The Environment Centre of the City of
Jarno Portti	HKL- Infra-Services
Jouni ticks	Betoniviidakko Oy
Karoliina Saarniaho	WSP
Ari Savolainen	Binding
Matti Tauriainen	HKL- Infra
Minna Torkkel	Transport Agency
Timo Tirkkonen	Transport Agency
Jukka Lahti page	Ramboll
Veera Sevader	Ramboll
Ilkka Vilonen	Ramboll
Kalervo Mattila	Ramboll
Jukka Räsänen	Ramboll
Arto Ruotsalais	Ramboll
Riina Känkänen	Ramboll

2 Assessment of overall sustainability

2.1 Definition of sustainability

There is no one commonly accepted definition of sustainability. There are at least 386 differentdefinitions of sustainability in Jacobs (1995). Initially, the concept of durability has most likely been used to describe the characteristic of a particular subject or object: sustainability as a characteristic has indicated that a matter or object lasts over time, i.e. remainsso.

The concept of sustainability was brought within the scope of research and social decision-making by the UN in 1987 (Brundtland 1987), raising concerns about future generations and global inequalities. In broad terms, sustainable development was considered to have three operational dimensions: **the ecological, economic and socio-cultural dimension**. For the purpose of this report, the definitions of the dimensions of sustainabilityset out in the box below (MS 2013) are used.

According to the UN report (Brundtland 1987), human development should bea constant and guided change in society at world level, regionally and locally, with the aim of securing a healthy life for present and futuregenerations. In addition to social justice, the report also gave significant attention to EkoloGine's sustainability, which was limited in particular to the conservation of natural resources, todepletion and minimisation of waste, and to the protection of ecosystems asa whole in order to preserve the conditions for life.

Environmental sustainability
Ecological sustainability means acting within the carrying capacity of nature, creating-sustainable use of non-resources and preserving biodiversity. Environmental sustainability includes environmental protection and management, responsible consumption and production, eco-efficient infrastructure and pollution prevention. Respect for the precautionary principle is key to environmental sustainability. In its view, the postponement of measures to prevent environmental degradation cannot be justified by the absence of full scientific evidence. Other important principles are the preventionof nuisance at source.

Economic sustainability
Economic sustainability is a balanced growth that is not based on long-term deleveragingand the destruction of reserves. A sustainable economy is a prerequisite for key societal functions and socio-economic transformations. The long-term pursuit of economic policies creates the right conditions for safeguarding and enhancing nationalwelfare. A sustainable economy is the basis for social sustainability.

Socio-cultural sustainability
In the context of social sustainability, the key issue is to ensure the intergenerational transmission of well-being conditions. Social sustainability means fairness, acceptance of diversity, equality, security, transparency, jointwork, etc. Social sustainability is also linked to the quality and comfort of the living environment, health, well-being and quality of life, participation and empowerment, prevention of exclusion, membership of the community, etc. Cultural sustainability includes the preservation of cultural diversity and identity, the preservation of cultural heritage and valuable landscape sites, etc.

Overall sustainability aims to strike a balance between ecological, economic and socio-cultural sustainability. These three dimensions are usually structured in differentways, one describing so-called " **low sustainability**" and the second one illustrating **strongsustainability**.

In the case of so-called weak sustainability, the economic, environmental, socialand turbulent dimension (capital) is substitutable, i.e. an increase in one capital can compensate for the decline in the capital of the other. This arrangement is often illustrated by a pattern in which the three rings are superimposed in such a way that the common circumference in the centreof the circumference reaches the centre or, more specifically, the concept of durability (Figure 2).

The so-called “strong sustainability” is close to the opposite to low sustainability. Ecology,-economic, social and cultural capital are merely complementary, withthe result that different types of capital cannot replace each other. This configuration is often illustrated in a pattern where three tyres are placed together. The outer circle depicts the ecosystem and its ecological capital, the middle sociallist of the field and socio-cultural capital, and the inner economic system and itsland capital. As human-generated capital (including the economic and social end ofits own) cannot, according to this conceptualisation, replace natural resources and processes,we can protect and save natural capital for present and future generations (safeguarding natural resources and carrying capacity).

Figure 2. The dimensions of sustainability have been used to structure two different ways, from which the left-handarms depict weak sustainability and strong sustainability on the right side.

The overall sustainability of the Kruunusillat project has features of both low and strong-resilience. Low sustainability is demonstrated by the fact that the project has both positive and negative impacts, with different local and regional impacts. For example, at local level, the project will significantly change the perspectives and landscapes of existing areas, while at the same time enabling the development of new neighbourhoods, promoting sustainable mobility and reducing greenhouse gas emissions from transportat sub-regional level. As is typically the case for many projects, opportunity costs (effects) are therefore in place. Strong sustainability is demonstrated by the project's efforts to save natural resources. This may be demonstrated, for example, by the fact thatthe land is used in the construction work for land or from other construction projects, which saves costs (economic sustainability) and avoids the wear and tear of natural aggregates (ecological sustainability).

2.2 Sustainability assessment

2.2.1 Sustainability Elements and Indicators

The assessment of the overall sustainability of the Kruunusillat project is based on sustainability elements and indicators. **The elements** of sustainability structure the concept of sustainability and seek to appreciate **what sustainability meansat different stages of the Kruunusillat project's life cycle and at different levels**. The elements of sustainability also reflect the overall goals of sustainability, i.e. the generally accepted and targeted trends that theproject should pursue (national spatial management targets, city strategies and programmes, Helsinki's 2050 targets).

Indicators are indicators that summarise and simplify the evaluation path toa more understandable and comparable format. The indicators are thebasis for monitoring and the data they provide can be used to assist planning and decision-making (Rosenström & Palosaari 2000). Indicators can also help to ensure thatthe targets for sustainability components are passed on to each level of design and implementation.

The sustainability components and indicators of the Kruunusillat project have been developed on the basis of the reference framework presented in Figure 3. It has been found that the individual metrics are insufficient to reflect the overallsustainability of a country's complex system. A number of different definitions andcontexts of sustainability also make it difficult to establish generally accepted methods of assessment andmetrics. As a result, the use of combinations of different assessment frames, rather than relying on only one single meter or instrument, has been introduced to measure sustainability. The reference framework for sustainability of the Kruunusillat project is the objectives set by Helsinki for theproject, the overall goals for sustainable urban development and the Arrival Framework of the CEEQUAL international classification system for infrastructure projects (see section 2.2.2).

Figure 3. Reference framework for assessing the overall sustainability of the Kruunusillat project.

It has been concluded that sustainability cannot be seen as an objective that either materialises or failsto achieve. Sustainability should be seen as a continuous improvement and process (Correia 2015) that encompasses the entire life cycle of the project. For the purpose of sustainability assessment, the Kruunusillat life cycle is divided into key phases (Figure 4), each of which has defined sustainability elements and indicators. Decisions taken at each stage of the project have an impact on the overall sustainability of the project. It should be noted that the orientations and solutions taken at the initial planning stage have the most significant impact on the overall sustainability of the project. RAduring fielding and use is significantly less likely to act.

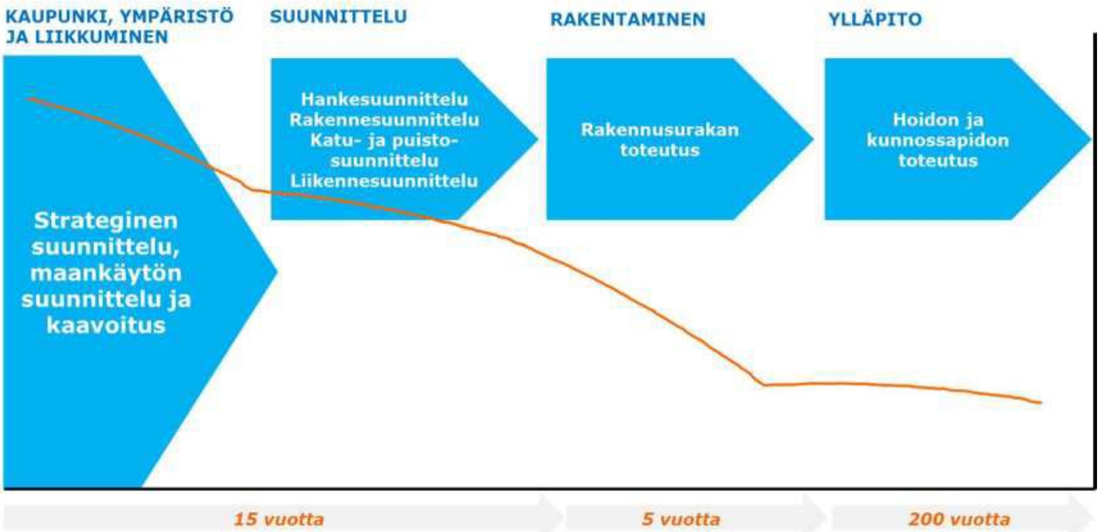

Figure 4 The main life-cycle phases of the project (estimated duration) and the potential for influence (orange dash). Strategic orientations and early planning solutions have the most significant impact on the overall sustainability of the project.

Assessment based on sustainability elements and indicators may be carried out during a specific life-cycle phase of a project (e.g. project design assessment) or at the end of a certain phase (e.g. assessment of a completed urban development plan, assessment of the realisation, construction or completionof construction, etc.). However, elements and indicators can be used even before the start of a certain life cycle phase. They can be used to support the setting, monitoring and decision-making of project-specific objectives. For example, the maintenance resilience elementsand indicators described in section 3.4 can already be used for project designand design. The sustainability elements of the construction phase and the dictators set out in Chapter 3.3 canbe used for competitive tendering by the construction contractor.

International Taxonomy for Sustainable Development of Infrastructure Projects (CEEQUAL)

Various international sustainable construction classification systems have been developed to support the sustainability of the built environment. The purpose of the rating systems is to increase thevisibility and reproducibility of the assessment and the comparability of the different items. Servitisation of sustainable development isalready well established in the real estate and construction sector, both internationally and in Finland. In recent years, sustainable development serification at regional level, which guides spatial planning and spatial planning,- has also become more widespread.

The most well-known sustainable development rating tools developed for infrastructure projects are CEEQUAL **from** British origin, INVEST and AGIC IS from Australia, and the American lawset Greenroads, GreenLITES and Envision. The British CEEQUAL, published in 2003, is currently the most well-known in Europe and the Nordic countries, and the International version is suitable for use outside Ireland and the UK for different types ofinfrastructure. The nearest CEEQUAL certified infrastructure projects can be found in Sweden. Due tomo motiveness and Nordic familiarity, the CEEQUAL classification system is used for this assessment of the overall sustainability of the Kruunusillat project as one of thereference frameworks.

CEEQUAL evaluation and certification may be carried out for the project as a whole, covering the whole project area or, in the case of large projects, it is possible to divide the project into appropriate subsets that can be adapted to day-to-day care. In addition, the whole project may be certified, covering all stages ofthe project, or alternatively, the phases to be certified, e.g. design and/or construction, may be selected.

Under the certification scheme CEEQUAL version 5.1, the overall sustainability criteria are composed of around 200 questions, divided into nine categories:

- Project strategy
- Project management
- People and society
- Land use
- Cultural History Environment
- Ecology and biodiversity
- Water bodies
- Transport
- Consumption of natural resources

The CEEQUAL evaluation system guides project-specific impact assessment, the setting of objectives, the selection of indicators to be monitored and the monitoring of their achievement. AR vigorouslytakes into account both the specific characteristics of the project and the national context, how the localclimate conditions, the specific features of the cultural environment and the regulatory steering effects are taken into account. The weight of different categories and questions differs from one country to another.

In general, the benefits of sustainable development certification are seen as thecumbersome process, which is highlighted by large-scale, multi-actor and multi-stakeholder regional and infrastructure projects. The system allows for a consistent approach to steering a project throughout the life cycle, drawing on best practices. In addition, the certification of a third-party, which is not trapped, verifies the sustainability of the project, which may also create a real image value.

3 Assessment of the overall sustainability of the Ruunusillat project

3.1 City, environment and mobility

Sustainability must always be seen primarily from the perspective of large entities. The assessmentof sustainability also requires account to be taken of the causal and mutual effects of the various measures. The sustainability components of the Kruunusillat project “City,-circumstantial and mobility” are set out in Table 2.

When assessing the overall sustainability of the Kruunusillat project, it should be stressed that the project is not only a public transport link between Laajasalo and the constituency, but is part of the wider strategic development of Helsinki’s urban structure, land use and transport. The Kruunu-Bridges project contributes to meeting the forecasts of population growth in Helsinki and the region, asthe current service capacity of the transport network is not sufficient to secure a viable nose inthe Kruunu Mountain and the Larjasavo. The project will also support the efforts of the city ofHelsinki to increase the share of sustainable modes of transport, i.e. public transport, walking and cycling inthe fields. The Kruunusillat project is linked to the development of a railway traffic ver-hulled city in accordance with the Helsinki Master Plan by enabling a community based ontramways to complete the structure and implement the maritime conurbation:

- On the Crown Mountain
- Around Yliskylä and elsewhere in the Broadtail
- In the longer term in Vartiosaaari, Rastila and Vuosaare

The Kruunusillat project also links the fishing port and the Nihdi district in particular tothe metropolitan city. In the Large Room, the public transport connection of the Kruunusillat project connects the regenerating business and service centre of Yliskylä and the local centre inthe Kruunu Mountain. The service self-sufficiency of the lagoon will increase and the island’s dependence on theservices of the Hertto nie will decrease.

Table 2. Elements of sustainability in the “City, environment and mobility” package of the Kruunusillat project

Sustainability dimension	Elements of sustainability
Economic sustainability	Increase in tax revenue Increase in value of building rights The economic viability of the investment
Environmental sustainability	Reducing greenhouse gas emissions Resource efficiency Maintenance of ecosystem performance
Social and cultural sustainability	Improving people’s well-being and improving the conditions for well-being Implementation of participation Developing urban images and safeguarding cultural heritage

The impact of the Kruunusillat project on tax revenue has been studied in the urban economic assessment of the tramwayyh track of Raide-Joker and Laajasalo (urban study TA and Strafica 2015). The realisation ofwho has an impact on the city’s tax revenue and, consequently, on the cost of services. The project will create the conditions for housing and facility production, allowing residents and businesses to be located inthe area affected by the project. Residents pay municipal taxes and, on the basis ofthese charges, the municipality receives state shares in the operating economy. On the other hand, local services generate costs. Companies pay corporation tax, part of which the city receives. Land andbuildings owned by a private ten are subject to property tax. The project may also have an impact on the characteristics and level of income of residents selected in the catchment area,who continued to determine the level of tax revenues and the costs incurred.

According to the urban study, the tax revenue paid by households, enterprises and property owners in the tramway zone exceeds the service charges. The share of net tax revenue over a 30-year period in the Broadtail is EUR 10 million. In addition, the City receives tax revenue from theactivity and wages generated by the construction of tramways and buildings. It is estimated that the annual employment effect during the construction of the Kruunusillat project is about 520 man-years and the annuallabour need is 60 man-years during operation. The annual employment impact of the construction of a building dependent on the tramways of the Large Storage is about 240 man-years.

3.1.2 Increase in the value of the right of construction

The capacity for housing in the tramway zone of the Large Strait corresponds to 7 % ofHel Sing's total potential. In the area of Largesalo, the implementation of the tramway link will have a very significant impact on the accessibility of the area by mass traffic and bicycles and, accordingly, the importance of implementing the project in terms of land prices in the region and the cash flow of the city is ofparticular importance. In addition, it should be borne in mind that the Kruunusillat project provides for the possibility of sharing atramway network east of the Laajas basin.

The present value of the city's sales and rental income is EUR 33 million higher when the tramway link in the Larayago takes place, and the present value of the land use contract compensation is EUR 7 million higher than that of the project. Taking into account the share of the construction of the Vartiosaaari, thefigures were EUR 85 million and EUR 10 million respectively. (Urban study TA and Strafica 2015)

The implementation of the Ruunusillat project and the resulting change in accessibility will increase the value of the buildings built in the tramway catchment area by about 10 % according to the calculation. The increase in value of the building stock owned by the current city of Laajasalo is EUR 14 million, of which EUR 13 million for Yliskylo. The construction of the railway link increases the value of the nypen and the future building right on the city's land by approximately EUR 124 million compared to the optionof not implementing the tap. The increase in value amounts to 23 % of the value of the building right. In the rest of the catchment area, where the city has a land share of almost 90 %, the impact is around EUR 35 million (around 4 % of the valueof the building right). The major part of the change in the value of the existing and future building right in the large basin (EUR 100 million) is on the Kruunu Mountain, where, due to the nature of thetrack, the level of accessibility is completely different from that of the bus/metro-link. The impact is also significant in Yliskylä (EUR 20M).

From the point of view of residents, areas where accessibility is improved as a result of the change in the transport system will become more attractive places of residence. Shortening travel times will indirectly bring an invaluable benefit to households. This increases the willingness of householdsto live in an area where accessibility is improved. This in turn leads to higher house prices and rents in these areas in relation to the previous transport system and accessibility. Improved accessibility and the consequent increase in demand, or in the spawning area, willincrease the attractiveness of the area as a construction area. It creates the conditions for planningnew areas and for rebuilding old ones.

3.1.3 Economic viability of the investment

It is important to take into account life-cyclecosts (LCC) when calculating the economic viability of the investment. From a life-cycle perspective, it is essential that design of the lifetime, maintenanceand reparability of the structures, as well as the costs of maintaining bridge structures, streets and parks, are taken into account in projectcost assessments. The identification of resource-efficient alternatives may increase planning costs, as well as possibly also costs such as bottom-up research. However, when linking resource efficiency information to the life-cycle cost ofa project, it is often noted that resource-efficient planning is less costly than a traditional one.

According to the guidelines of the Transport Agency, life-cycle cost assessments should take into account both direct and indirect costs. Direct costs are construction costs and maintenance costs, which are relatively easy to view in terms of volumes andretention periods. On the other hand, the different risks inherent in indirect costs are significantly more difficult to estimate inrelation to net changes. The cost of risks andthe costs of the road operator, user and society are still borne separately. In addition, indirect costs include environmental costs and driving costs in terms of time costs.

The main issues affecting the direct costs of the project and the design tobe taken into account are:

- design of the load-bridging parts of the bridge for the entire target lifetime
- design of maintenance and refurbishment components in such a way that maintenance and refurbishment operations of different components that are directly connected to each other can be carried out at the same time;
- material selection with maximum length of maintenance and renovation periods (i.e. minimum effort during the bridge's life cycle).

The design of indirect costs may, inter alia, include the design of the refurbishment of building blocks requiring renewal in such a way that the connection is not completely crossed during the repair.

In terms of economic sustainability, the Kruunusillat project contrasts withdirect brutal effects and valued factors. Direct traffic operation, management and maintenancecosts are increasing. On the other hand, the calculated value of the time saved when travelling andthe reduction of road accidents and emissions will lead to savings. The main environmentalimpacts during use are related to changes in traffic patterns and the performance of different modes of transport. Although the traffic pattern over a large area (growth of fields below 0.1 % orincrease in the number of public journeys by less than 0.2 %) is offset by small trafficpatterns, an increase in the number of public journeys by almost 13 000 journeys per day will have a significant impact on the corridor of the Eastern Corridor. The Kruunusillat project eases the pressure of the population growth in Larasalo on themetro, the connection to the Herttoniemi metro station and also on vehicle traffic.

Mobility is also accompanied by improved accessibility. This is illustrated by the fact that, according to design roads, the total journey time in public transport is slightly decreasing, even though the number ofjourneys and the number of journeys are increasing. On the other hand, model projections show that the combined amount and share of walking and cycling would decrease by almost half of that ofcar traffic. In this respect, it may be considered whether the models drawn up on the basis of the current situation really capture the effects of a new fast and smoothlong-distance cycling link in the future, as e.g. e-bikes are much more common.

The cost of operating bus services and underground traffic will be reduced by about EUR 7.3and EUR 2 million a year, while the cost of operating tram services increases byEUR 14.4 million per year, the net effect is an increase in operating costs of EUR 5.1 millionper year (Transport Model Rivers, KSV 2015b). Another growing cost item is maintenancecosts of EUR 1.3 million per year (urban study TA and Strafica 2015). Taking into account the estimated increase in ticketing revenue of at least EUR 0.8 million per year, the total additional cost will be around EUR 5.6 million per year.

The costs of the project have been reported in the separate Kruunus bridges, Raitio Road link to Laajasalo, in the Cost Report (2016).

Table 3. Indicators and general objectives for assessing the economic viability of the investment in the Kruunusillat project

Indicator	**Objective**
Project life-cycle costs	Minimum life-cycle costs, but with or without downgrading the desired quality level (= avoided costs, EUR)
Life-cycle cost of the project per user	Minimum life-cycle cost per user (EUR/user)
Benefit-cost ratio	Maximum benefit in relation to investment

3.1.4 Reducing greenhouse gas emissions

The City of Helsinki has set the objective of developing the transport system in order to promote sustainable modes of transport by developing rail transport, increasing the level of public transport, and increasing walking and cycling facilities. The city also aims to degrade the urban fabric in response to climate change by extending the rail network.

The impact of the Kruunusillat project on traffic distribution and the promotion of sustainable mobility at transport system level has been assessed in various contexts (EIA 2014, KSV and Strafica 2013, HSL's new traffic forecasts for 2015). The results of the evaluations are in the same direction. The following figures are based on HSL's latest forecasts for 2040:

- Car mobility is reduced by 4.5 million car-kilometres per year.
- Bus performance is reduced by 2 million wagon-km per year.
- The performance of the metro will decrease slightly and the tram service will naturally increase by about 1.5 million kilometers, but electricity is assumed to be zero-emissions.

Based on the environmental impact assessment carriedout in 2014, the Kruunusillat project will reduce CO2 emissions in the Helsinki region in the future. In a more accurate calculation carried out in 2015, a new transport model has been used and the area covered by the model is wider than in the past (KSV 2015b). The reduction of CO_2emissions as a result of the introduction of the tramway system is 4 100 tonnes per year. About the fourth part of the savings is due to a reduction in passenger car traffic, just over half of the savings are due to the replacement of bus transport by electric public transport, and tothe benefits of e.g. freight transport. This corresponds to 0.12 % of the CO2 emissions in the field covered by thetransport model.

At regional level, the project has a positive air quality impact and contributes to the fight against climatechange. The results of the climate change clearance and adaptation study carried outin the context of the project design will be taken into account in the design solutions and procurement.

3.1.5 Resource efficiency

Resource wiseness is becoming increasingly important in society, both for sustainable economic growth and for people's well-being. Our society should be developed towards a circular, carbon-neutral economy — a new economic system in which value-added and well-being are achieved through asignificantly reduced use of natural resources. It is not only about more efficient use of resources, but also to improve productivity and quality, accountability and rationalisation.

Resource wise is particularly important for construction, as the construction of streets, parks and houses is oneof the biggest natural resource consumers in Finland. Finland uses the second highest percentage of land per inhabitant in Europe, with a total of about 120 million tonnes per year. Construction, including surplus countries, generates more waste per year than services and households combined. More than half of the waste in the metropolitan area is generated by civil engineering and the largest single type of waste isin surplus countries. Measures to improve the resource efficiency of construction will benefitboth urban, business and environmental communities.

From the point of view of resource efficiency, it is essential that the land that decidesto use construction is used efficiently and other areas are left to nature where possible,or to save space for activities that have a positive impact on the comfort and well-being of the areas. Reducing the use of land and natural resources is an increasingly important factor inreducing the environmental impact of a project throughout its life cycle, achieving cost savings and improving the quality of the project. In particular, the national spatial-use objectives recognise the need for urban integrity, thebalanced development of urban areas based on existing centres, the reduction of the need fortransport by car, the creation of housing conditions and the need to adaptto mast change.

The Kruunusillat project makes effective use of the existing urban structure and it is possible tolist the rebuilding and consolidation of land use by ensuring a smooth, competitive and comfortable public transport connection to the Kruunu shore. The Kruunusillat project is also an effective link between the fishing port and the Nihdi district inparticular. In the Large Room, the public transport connection of the Kruunusillat project connects the regenerating business and service centre of the Ylisky west and the nearby cost to the Kruunu Mountain. The project will allow for a more efficient developmentof the Kruunu Mountains into a multifaceted, concise and sustainable residential area with good tram and light traffic connections to the hub and bus and passenger car connections towards Herttoniemi.

The Ruunus Bridge project reduces vehicle traffic and thus reduces infrastructure, pathways and parking which areinefficiently used for vehicle traffic, which remove space from other activities. The extension of the rail network shall take into account in particular theuse of periphery and the surrounding environment, the continuity of green spaces, and the expansion of the metro network to thewest and east.

3.1.6 Maintenance of ecosystem performance

Ecological sustainability requires that human activities are placed within the limits of natural carrying capacity in such a way that biodiversity and ecosystem functionality are not jeopardised. In particular,the regional use objectives state that spatial planning must contribute to preserving the multiformity of areas that are valuable and sensitive to living andnon-viable nature, and to prevent and reduce thenuisance of noise, vibrations and air pollution.

The natural environment of the project area of the Kruunusillat project ranges fromurban to near-natural ticks. Most of the project area can be considered to be affected by human activity.

In the centre, Katajanoka and Sompa Islandstill have small patches of the natural environment. Beaches are built.

The impact of the project on the functioning of ecosystems during the construction of the project is temporary. Asa preliminary sign, the effects on fish and fisheries are mainly causedby water build-up and therefore only temporary. Lasting or cumulative effects are more significant than the construction time. The lasting impact on fisheries and fisheries is estimated to be limited. The effects in the terrestrial ecosystem during use are estimated to be the closest tothe bird population.

In addition to ensuring the living conditions of individual species, attention must be paid to the preservation oflife-style work and the ecosystem services that produce them. The construction of the Kruunusillatproject will change and destroy habitats. As a result of the link, some of the-land already built will be transformed into a built-up “urban” environment. The use of extensive recreation areas inthe Brigade, the Island of Korkein, the Kruunu Mountain and the Large Shelf will increaseand diversify. This increases the operational pressure on these habitats over the years. The naturereserves in the vicinity of the tap are not affected by any impact which would-alter the characteristics of the sites or impair their speciesal characteristics. There willbe no impact on vegetation and habitats in the surrounding areas. The project will also create new habitats suitable for species and may allow species to spread into new habitats.

3.1.7 Improving people’s well-being and improving the conditions for well-being

The aim of the City of Helsinki is to make the whole of the Kruunu Mountainsarea firmly based on traffic. A residential area of approximately 11 000-13 000 inhabitantsof Kruunu Mountain is planned for the site of its oil formerly operating on the western shore of Helsinki Laajasalo, which would also host around 1 000 jobs. The environment of the area has been rehabilitated and thepre-build has been rehabilitated, and residential construction started in 2014. There are also plans for the way inwhich additional construction works are planned, very roughly estimated, Yliskylä and the restof the Laajasa lount have an additional potential of about 11,000-15,000 inhabitants and Vartiosaaari around 5,000-6 000 inhabitants.

The Kruunusillat project will provide support for a high-quality public transportconnection and will contribute to meeting the growing demand for urban housing by connecting the areas released from the oil port of Kruunu Mountaina to the metropolitan city and supporting the rebuilding of Laa and Yliskylä regions. The project also relies on environmental pull factors such as maritimeity and increases recreational opportunities for people affected by the bridge and tramways. The project will improve people’s mobility and accessibilityto recreational areas and provide a new recreation route.

The extension of the railway line to Yliskyla will strengthen the attractiveness of the Laajasalo and increase the attractiveness and attractiveness of the region as a residential area, thanks to better centrality and accessibility, as new and many existing neighbourhoods have an uninterchangeable rail connectionto the centre. The advantage of the rail linkfrom the perspective of the attractiveness of residential areas can also be seen as its ‘permanence’ and ‘domesticity’. The project will also shorten walking and cycling connections from the Broad basin to the metropolitan city by about 6 km, which is predicted to significantly increase, in particular, cycling. This typeof development will also lead to positive health effects of beneficial physical activity.

In the case of the Kruunusillat project, there are differences between the orientation options in the conurbation city in terms of the daily movement of people. Under the Hakanibe alternative, cyclists will have more diverse choice of light-traffic routes across the metropolitan area. From the point of view of public transport users, Hakaniemi's option has the advantage of a smooth-connection with the metro, other tramways, the buses of northern Helsinki and, in the case of adroplet, also for local trains. Alternatives to the Ruunuhan can be perceived as attractive due to its metropolitan nature, but this also brings the challenges of adapting tramwayand light roadway to street space. Under all options, the new bridge links will significantly improve the mobilitypatterns of Sompasaari and, in particular, of the residents of theNihd region.

Tramway traffic causes noise and vibrations. The advantage of the Ruunusillat project is that there are few activities in the immediate vicinity of tramways that should beprotected from noise and vibrations in different ways. The layout of future residentialconstruction sites shall determine the necessary provisions to combat noise and vibration. In the case of the High Island and Palosa Island, as well as at other locations sensitive to noise or vibration, technical solutions can be used to mitigate the impact.

3.1.8 Implementation of participation

Participation and interaction in the Kruunusillat project has been carried out several times in different design packages. The participation has been organised through the public transport exchange procedure in Laajasalo and the related planning projects in accordance with the EIA and Land Use and Building Act. At the bridging stage, there was a lot of material available, for-example, on the web where information on the project is further disseminated. The risk workshops have involved stakeholders toaddress and prepare for the potential risks of the project.

3.1.9 Developing urban images and safeguarding cultural heritage

Once implemented, the Kruunusillat project would be reflected in the Finnish Castle, but this is not seen as threatening the preservation of the values of the World Heritage Site. In addition, the bridge is located outside the protectionzone of the world heritage site. In addition, when assessing the significance of the effects, account must be taken of the location of the project in a location where the surrounding area has been strongly shaped by the growth and development of Helsinki. The Kruunusillat project will make the key maritime urban space in Helsinki more accessible to residents. The project will create new and attractive places for residents and tourists. A new connection — telecoms attracts people to move.

Design

The Kruunusillat project consists of a number of design packages. The sub-division of the Kruunusillat project is as follows (in brackets, the corresponding designer for the area in question and the plan toplan so):

- 00007, Centre C: Rautatientor — Hakaniementor (Trafix, Pre-plan)
- 00008, Centre B: Mikonkatu — Liisankatu (Trafix, Pre-plan)
- 00009, Centre A: Rautatientor — Aleksanterinkatu (Trafix, Pre-plan)
- 00011, Centre A: Aleksanterinkatu — Nihti (Pontek/FCG, Preliminary Master Plan)
- 00013, Centre B: Liisankatu — Nihti (Pontek/FCG, Preliminary Master Plan)
- 00014, Centre C: Hakaniemi — Nihti (Ramboll, Preliminary Master Plan)
- 01040, Cruunuhaka, boat quays (WSP, Master Plan)
- 10302, Tramway (Sito/HKL, cost estimate)
- 00001, Nihti-Kruunu Mountain Bank, Finkens Bridge, High Island, Kruunu Mountains (WSP; master plan)
- 49460, Cruunu Mountain Coast — Archipelago Fleet (WSP, Master Plan)
- 49410, Archipelago Fleet Katu — Haaakon Bay Strait (Sito/HKL, cost estimate)
- 49440, Bay of Haakon branch, south (Sito/HKL, cost estimate)
- 49441, Bay of Haakon branch north (Sito/HKL, cost estimate)
- 49320, Gulf of Haakon — Reiherintie (Sito/HKL, cost estimate)
- 49110, Reiherintie — Large Flood (Sito/HKL, estimated costs)
- 49100, Yliskylä A, B (Sito/HKL, estimated costs)

The master plan for the Nihti-Kruunu Mountainranta section of the Kruunusillat project has been completed (WSP 2015). The development of a road and bridge plan is ongoing. Preliminary master plans and tramway master plans have been drawn up for the sub-city sections. The tramway masterplan was completed in February 2016. The preparation of the project design for the Kruunusillat project is ongoing and will be completed in April 2016. The objective of the project design is to improve the management of the whole set of separate assignments for the Kruunus slot by describing the different stages of the process through the project and anticipating the necessary measures for implementation. The project plan serves as a support and tool for thedecision-making process of the City of Helsinki.

Concrete objectives for the overall sustainability of the project will be set in the planning. From an overall sustainability point of view, it is essential that the strategic goals assigned tothe project take the form of concrete sustainable planning solutions and procurements. Designers will be responsible for obtaining information on the overall sustainability of the project, comparing alternativesand assessing risks together with the contractor. They are also responsible for the size ofthe structures and the drawing up of implementation plans, as well as for defining the necessary audits and inspections duringthe construction project. The objectives of the overall sustainability ofthe project may, for example, have an impact on the working methods and equipment used, as well as on thephasing-in and monitoring of the project.

A life-cycle perspective should be taken into account in the planning process. The objective is that the technical functionality and usabilityof the project will be achieved with minimum life-cycle costing andlife-cycle impacts. From the point of view of sustainability, this involves both the determination of the useful life of the structures and the design of the maintenance and reparability of structures. The long lifetime of the structures and the limited need for maintenance increase both the freshness andthe environmental sustainability of the project. Resource-efficient design solutions can directly reduce resource consumption, emissions and costs as well as, indirectly, other environmental impacts of the project. An important aspect of sustainability is also to ensure that planning solutions are adapted to the urban image.

The overall design sustainability assessment framework set out in Table 4 may be integrated into sustainable planning. Sustainability components make it possible to assess different design options from the point of view of sustainability. They will also help to ensure thatthe objectives set for the sustainability of the project are passed on to eachlevel of planning and implementation.

The overall sustainability assessment framework has been used to assess the overall sustainability of the Hakaniemi-Nihti Preliminary MasterPlan and the Nihti-Kruunu Mountain Bank section. Thefailures are set out in Annexes 1 and 2.

Table 4 Elements of sustainability in the design of the Kruunusillat project

Sustainability dimension	Elements
Economic sustainability	Investment costs Lifespan of structures Maintenance and repairability of structures
Environmental sustainability	Resource efficiency Maintenance of ecosystem performance
Socio-cultural sustainability	Using local experience and know-how to develop urban images and preserve cultural heritage;

3.2.1 Investment costs

The costs of the project have been reported in the separate Kruunus bridges, Raitio Road link to Laajasalo, in the Cost Report (2016).

3.2.2 Design of the lifetime of structures

Investing in long-lived structures not only saves costs in the use phase, but is also the most effective in terms of women's overall sustainability. The long lifetime of the structures and the limited need for maintenance will also improve the environmental sustainability of the project, as the overall material consumption over the whole life cycleis minimised. Fields lasting two hundred yearsshould be designed and implemented with special concern. Structural components with significantlyshorter lifetimes, such as typically physical welds, water insulation and edge beams, are designed to be renewed in the same cycle.

Streets:

- The required service life of the street constituents is set out in InfraRYL2006 in the performance requirements of the street structure (the table shows the lifetime requirement for some building elements);
- The choice of the bottom construction/bottom reinforcement method (e.g. ballast/pillar-stabilisation/ke stretching) affects the structure's in-use deflections and the need for repair byshirts, if any;
- The design of street structure layers (e.g. split layers) has the potential to influence the useful life of the superstructure, which has a direct impact on repair and renewal needs (e.g. less deformation of the coating on more rigid layers)

Bridges:

- Bridge supporters, deck, pylon and cables to be designed for the entire service life and minormaintenance needs
- Water insulation, physical seams and edge blocks, starting with 40 years of renewal

Table 5. Indicators and general objectives for the lifetime planning of the structures of the Kruunusillat project

Indicator	**Objective**
Useful life of the main building blocks	200 years
Useful life of the wearing parts of the	40 years
LCC/life (EUR/year)	The project must be financial over a longperiod of time;
Load-bearing, partitioning and filter	40 years/to be defined by project (InfraRYL)
Street pad wall	100 years
Street ground structures and bottomwriting vistus (painting and shavings, pillar and mass stabilisation)	100 years

3.2.3 Maintenance and repairability of structures

The maintenance and reparability of bridge and street structures has an impact on durability. Structures shall be classified according to their intended service life, serviceability and reparability. Materialchoices that require as little maintenance, repair or renewal as possible during the life cycle of a building are also the best choices in terms of overall durability, as the overall material consumption is often the lowestin total. The limited need for repair and renewal also has a positive impact on the undisturbed use ofroads.

Table 6 Indicators and general objectives for the evaluation of the maintenance and repairability of the structures of the Kruunusillat project

Indicator	Objective
Useful life of bridging structures	40 years or more
Useful life of street covering (AB, natural stone, concrete stone)	to be defined by project
Useful life of street superstructures	30 years/to be defined by project (InfraRYL 2006)
The lifetime of the technology under the street (drinking water sewers, etc.)	50 years, renewal when the street superstructure is renewed
Maintenance and repair costs (EUR/200 years)	Minimum maintenance and repaircosts over the lifetime of the project

3.2.4 Resource efficiency

In the case of the Kruunusillat project, research into resource-efficient alternatives is primarily related to the selection of structural materials and the consumption of soil and aggregates. Resource efficient design not only reduces resource consumption and emissions, but also indirectly reduces other negative environmental impacts of the project. Design solutions to improve resource efficiency do not detract from quality requirements, but aim to achieve a lower level ofquality and added value. Reducing the use ofreservoirs leads to cost savings, increased competitiveness and reduced negativeenvironmental impacts.

Building materials and products

The construction materials of the Kruunusillat project will be selected in the implementation design, which will alsohave the most significant impact on the environmental impact of the materials. The technical, functional and lifetime requirements of the structures are a priority-when selecting ritual mathematics. As a whole, these starting points therefore prevail over the-most resource efficiency objectives. If the above requirements are met, attention can be paid to resource-efficient and environmentally friendly materials. When assessing the resource efficiency and environmental impacts of materials, attention shall be paid to:

- Long service life
- Comfortability
- Reparability
- The possibility of using recycled materials
- Possibility to re-use or recycle the material after use
- Low environmental impact in the manufacture, transport and use of materials

For new construction products, environmental guidance is currently largely based on CE marking and type-approval. CE marking for construction products has been mandatory since 1 July 2013 with the new Construction Regulation. Finland’s CE marking is based on the Act onthe approval of certain construction products (954/2012). The market surveillance of CE marked construction products covers around 80 % of all construction products. Other pieces of legislation that guide theenvironmental impact of construction products include the Ecodesign Directive’s guidance at EU level on the ecodesign of products (2009/125/EC), which are contained at national level in the Ecodesign Act (1005/2008). Supervision is carried out by the TEM and the CMO, who coordinate thepreparation of the cand and consult stakeholders. In influencing the content of legislative acts, it is important to act as early as possible. Eco-design aims to improve the energy efficiency ofroads by integrating environmental considerations and life-cycle thinking already into the product-design phase. The Government’s decision in principle aims to promote sustainable environmental and energy solutions, known as cleantech solutions, in public procurement.

The Government Programme (2011) included the promotion of life-cycle calculation of building materials and products. This is also encouraged by the CEEQUAL rating tool for infra-projects (Chapter 2.2.2). Life-cycle modelling is also becoming more effective as construction data modelsbecome more widespread. Standard per CEN TC 350 (Sustainability of construction works) has also been developed to standardiselife-cycle calculation. Information on the life-cycle impacts of building materials and products is available in product-specificenvironmental declarations, the so-called Environmental Product Declaration (EPD). The life-cycle effects of the product have been determined on EPD cards, from extraction, manufacture and transport of raw materials to thegate. Where EPD cards for product options are available from product manufacturers, they make it possible to compare the lifecycle circumference of different materials and, where possible, to favour the least effective products.

The manufacture of materials for the main building blocks of the bridge is more important for mathematical ritual efficiency and environmental impact than for the transport of materials. In Finland,the transport of concrete and steel structures is carried out almost exclusively byroad haulage. The proportion of transport is in class 5 % compared to the emissions caused by the production of the material for 100 km. As the distance travelled to 2 000 km, the number of works will increase to about 25 %. It is therefore advisable to favour near-prepared parts of building blocks where there is a large amount of non-individual assets thatare needed inthe construction project. For example, when comparing the environmental loads of natural stone and granite, transport distances can play a significant role. The production processes of traditionalbuilding masts such as concrete and steel also require a high level of energy and lead to greenhouse gas emissions. Recycling of both materials has a long tradition in Finland and at EU level. The recycling of metals, in particular, makes economic sense. After crushing, concrete is generally used in filling and road construction, less frequently in the manufacture of new concrete.

Where possible, the following environmental aspects may be taken into account in the selection of construction products and materials.

1. The adverse environmental impact of the product throughout its life cycle is minimised. Verification: Information provided by the manufacturer of the product on the life-cycle impact of the product on the EPD card of the construction product, other equivalent environmental declaration, certificate or other equivalent declaration of the manufacturer

2. Energy consumption and greenhouse gas emissions from the production of the productare the lowest. Verification: Information provided by the manufacturer of the product on the energy consumptionand emissions of the product’s manufacture. Manufacturing processes for construction products typically require a high level of energy and account for most ofthe product’s life cycle greenhouse gas emissions.

3. The CO2 emissions from the transportofthe product are minimised. Todentaminen: Information provided by the manufacturer on the place of manufacture of the product, the mode of transport, the vehicle and the modesoftransport used to calculate CO2 emissions. In the case of building elements that are highly committed to natural resources and are needed in the construction project, it is advisable, from the perspective ofthe whole of the building project, to favour near-prepared building elements. For example, when comparing the environmental loads of natural wolves and granite, transport distances may become in a position toa lesser extent.

4. The product has been manufactured using renewable or recycled materials. Todentaminen: Information provided by the manufacturer on the proportion of wood-based material or

recycled material (e.g. plastic, metal) in the finished product (% by weight)

5. Substances used for the coating of wood, plastic and/or metal components shall not be harmful to the environment or to humans. Verification: A statement by the manufacturer of all surface treatments used for otherchicken materials in the product, together with safetydata sheets or equivalent documentation.

The following resource efficiency indicators can be used to help design and compare theterms of the exchange.

Table 7 Indicators and general objectives for the assessment of resource efficiency of materials in the Cruunusillat project

Indicator	**Objective**
Total cost of construction materialsin relation to output (t/m^2) + maintenance and renewal material (t/m^2) divided by the lifetime of the structure	The use of materials as a measureof efficiency is commonly used as tn/m^3 or tn/m^2. When considering material efficiency throughout the life cycle of a structure, the total amount of materials should be further divided over the lifetime of the structure. The aim is to carry outthe project with a minimum mass of material and to achieve the desired level of service.
Share of recycled materials intotal consumption of bals (%)	Replacing virgin natural resources with tertiary recyclingin such a way that the total consumption of materials does not increase.

Land and aggregate consumption

Land and aggregate management (soil planning) of the Kruunusillat project can significantly contribute to the resource efficiency and environmental impact of construction. The objective of land planning is to balance the project's mass and to minimise transportwhile ensuring that the quality levels set out in the plans are achieved.

The mass balance of the project means avoiding tillage and dynamism of excavatedsoils where possible on or near the site. All theon-site surplus land is a resource that should be used for planning purposes in othersites. Virgin soils and aggregates are saved and replaced where possible by recycled and secondary materials. The land that is decided to be used for construction will be usedefficiently, and other areas will be left natural as far as possible. It is possible to limit the environmental impact of the excavation by minimising the number of excavated soils, e.g. by using unexcavated methods, by concentrating pipes on the same excavations and by using excavation sites in the fillings of the well and elsewhere on the site.

If secondary materials are considered at the site, it shall be established whether the site is located in the groundwater area (important or other suitable for water supply). Secondary materials includeindustrial and energy by-products and waste, as well as demolition waste (e.g. fly and bottom ash, concrete break). During the excavation of pipes etc., stabilised soil, often characterised by dry rinds (some harder and partly soft), is also excavated. Stabilised land can be used for fillings on the site. Stabilised land cannot be delivered to all landfill sites.

For street and park projects in the city of Helsinki, the designer must fill in the S10 tablefor the management of soil and aggregates (for more information: HKR/street and park department/mass coordinator).

If the soil in the design area is contaminated, contaminated soils shall be treated inaccordance with the provisions of the Removal Authority before or during construction. Soil contamination and remediation needs to be assessed whenever the soilcontamination threshold is exceeded (see VNa 214/2017). The areacan also benefit from harmful soils.

The following resource efficiency indicators related to soil and aggregates management can be used to help design and compare options.

Table 8 Indicators and general objectives for the evaluation of resource efficiency of mass management in the Kruunusillat project

Indicator	Objective
Total volume of land and aggregates-imported in relation to thatvolume (m^3rtr and t/m^2)	Carry out the project with a minimum amount of soil and aggregates.
CO_2emissions from the transport of land and aggregates entering the area in relation to output (t CO_2 /m²)	Carry out the project with a minimum amount of soil and aggregates and transport.
Totalvolume of land andaggregates to be transported and exported from the area in relation to output (m^3rtr and t/m^2)	Select the ground construction methodin such a way as to minimise the quantities of low-quality surplus land released by the building and the corresponding quantity of good-quality friction soil required — e.g. to avoid sub-creation by mass swaps. Treat surplus countriesin such a way that they can be exploited on-the spot. Processing may take the form of e.g. flap, screening, mass stabilisation, etc.
CO2 emissions from the transport of land and aggregates to be transported outofthe area in relation to output	Avoid the need to transport soil and aggregates.
Percentage of imports of virgin earth and aggregates (%)	Reduce the use of virgin soils and aggregates and replace them in appropriate parts with newindustrial and recycled materials. Take advantage of construction failures in the construction of nearby sites insurplus and in surplus.
Share of land and aggregatesdiverted to recovery as a proportion of land and aggregates transported out ofthe area (%)	Divert surplus landand aggregates from construction to useful use (e.g. for another construction project).
Percentage of land and aggregates thatcan be rocked and exploitable on the plot ofhard matter (%)	Exploit land-based excavations for construction (e.g. fillings). If necessary, provision is made in advance for the clearance ofexcavation sites.

3.2.5 Maintenance of ecosystem performance

Important aspects in the design of the Kruunusillat project include strengthening the characteristics of the area, natural storm water solutions, preserving the natural landscape accordingto the landscapes, and integrating green spaces into the wider retaliation of green and recreation.

Solutions in project planning and general planning (street andpark planning) can reduce the impact on natural conditions and biodiversityand safeguard the ecosystem services of the site. One of the main planning principles for the planning of the Kruunu Mountains has been the preservation of the non-spatial landscapeof the Kruunu Mountain bedrock after construction and the prospects from the sea on the direction of the Canton City and the Finnish Castle. The fitting of buildings in the area to challenging terrain has had a significant impact on the volume and height of construction. Efforts have also been made to preserve the natural state of the Crounu Mountains.

In the planning of the project, monitoring programmes will be drawn up, including:

- Water monitoring/application for a water permit surveillance programme
- Fisheries Monitoring/Water Permit Application Monitoring Programme
- Scoring monitoring

The following indicators can be used in planningto study ecological impacts and compare alternatives.

Table 9 Indicators and general objectives to maintain ecosystem performance in the Kruunusillat project

Indicator	**Objective**
Land use change by land use category, %	The land is being used efficiently and, where possible,-keeps the land in a natural state
Ecological status of surface waters, classification	The design solutions aim at maintaining or improving the ecological status of surface waters in the project area. As part of the planning process, in accordance with the city's storm water strategy, it will identify the drainage and delaying patterns of run-off water in the area, take account of the space theyrequire and draw up a storm water management plan.
Nitrogen and phosphorus emissions	Planning solutions aimto prevent or reduce eutrophication of water bodies.
Noise areas (above 55 dB) and number of people exposed	The design solutions aim at reducing the noise generated by the project. Noise also affects animals, such as bird species behaviour and other nature by limiting land use.

3.2.6 Making use of local experience and knowledge

The design of the Kruunusillat project is based on the concept and practice ofthe city of Helsinki. The design will take into account local architecture andconstruction methods. Design solutions must be feasible and appropriate to the project area and its conditions. The design employs Finnish planning agencies. The Kruunusillat project team will involve key players. The project's stakeholders, residents and users have been consulted as the project evolves continuously, including through the EIA procedure, town and country planning, and project-related events.

3.2.7 Developing urban images and safeguarding cultural heritage

The impact of the project on the landscape, urban image and the built and cultural environment has been assessed in the context of the initial EIA procedure relating to the Kruunusillat project and subsequently in the context of town planning. There are significant historical, cultural and landscape values inthe vicinity of the project and in the potential or potential area, which have been sought to be taken into account as starting points for planning. During the planning, there has been an activerogue with the museum authorities. In order to preserve the values of an area of cultural historical, architectural and landscape value, solutions have been sought in the design and layout of the bridge. (Source: Report on the interplay of the urban development plan for the public transport connection to the Kruunu Mountain, KSV 2015)

The construction of a project involves measures in specific values or theirproximity. The terraces and other construction works in the RKY of the High Island and Palosaare have significant local landscape effects. However, theconstruction of a commuter link will have an impact on areas where there are no buildings or significant surroundings duringthe herd's park. The landscape impact can be further reduced by quality planning in coastal areas. The project will develop a-monitoring programme for landscapes and urban images.

Construction

During the construction phase of the Kruunus Bridge project, it is necessary to ensure that the sustainability of thecreams is passed on to implementation. Co-operation between project managers, designers andcontractors plays a key role in achieving the objectives. Impacts during constructioncan be direct effects on the immediate vicinity of the construction works, such as migration, deflection, groundwater depletion, vibration. The effects may also beintermediates or occur outside the construction site itself. Construction has an impact onthe use of wild litter, resource efficiency and climate.

The project contractors are responsible for managing the effects on the environment, etc. duringconstruction. Contractors are responsible for site planning and logistics, site water management and practical arrangements for the sorting and recovery of waste on the site. All contractors involvedin the construction must, together with the site management, arrange for theirown work to be guided and trained as required by the subscriber. Every operator on the site is obliged to report immediately on the findings of anyfailure to manage environmental impacts. Monitoring the achievement of the objectives set for the overall sustainability ofthe project should be included in the monitoring of the works;

During the construction phase, changes to the plans may also be made which may affect the overall sustainability of the project. When changes are made, the impact on the overall sustainability of the project should be assessed.

An assessment of the sustainability of the construction of the Kruunusillat project can only be carried out during the constructionphase. However, the sustainability elements and indicators presented here can already be bolsteredin the design of the project’s works programmes and in defining the internal environmental plansof the site.

Table 10 Elements of sustainability in the construction of the Kruunusillat project

Sustainability dimension	Sustainability component
Economic sustainability	Management of construction costs
Environmental sustainability	Reduction of greenhouse gas emissions Resource efficiency
Social and cultural sustainability	Reduction of noise, dust, light and vibration effects Security

3.3.1 Construction costs

The costs of the project have been reported in the separate Kruunus bridges, Raitio Road link to Laajasalo, in the Cost Report (2016).

3.3.2 Reducing greenhouse gas emissions

The indicators and general objectives for assessing greenhouse gas emissions from the construction of theKruunusillat project are set out in Table 11.

Table 11 Indicators and general objectives for assessing greenhouse gas emissions from the construction of theKruunusillat project

Indicator	Objective
On site electricity and heat consumption — its emissions	Reduce unnecessary consumption and emissions.
Non-road fuelconsumption CO_2emissions (CO_2eq/m^2)	Reduce unnecessary consumption and emissions. Purchase of energy-efficient and low-power machinery.
CO_2 emissions from the transport of materials (CO_2eq/m^2)	Reduce emissions from the transport of materials.
CO_2 emissions from the transport of soil and aggregates (CO_2- eq/m^2)	Reduce emissions from the transport of landand aggregates.
CO2 emissions from the transportof on-site waste(CO_2eq/m^2)	Reduce emissions from waste transport.

<u>On-site electricity and heat consumption</u>

The energy consumption of the site consists of the heatingof the building site's premises, its electricity consumption and the fuel consumption of machinery and vehicles. Electricity is consumed in the area and work lighting of the site, in site offices, in the use of electrical machinery and in electric heating. The aim of the works must be to ensure that the contractor pays for the electricity according toit. In practice, this is possible for the largest works. It is difficult to carry out a smaller number ofworks. The negative environmental impacts of electricity consumption canbe reduced by:

- On-site lighting solutions favour energy-efficient LED lights andfluorescent cats.
- Take account of the reduction in consumption in the design of on-site lighting and make surethat unnecessary lights are switched off when no work is done on the site and when working lamps are switched off when they are not used.

- Automation (e.g. motion sensors, i.e. manoeuvring) is used to control the lighting of the site.

The contractor may require contractors to report on energy consumption on a monthly basis or per quarry. For major works, the contractor installs the main meter and supplies the permit-KEMA, on the basis of which the contractor invoices the contractor for the energy consumed. Measuring and monitoring the energy consumption on the site can be used to set targetsfor consumption in the largest projects of scaling and address consumption deviations. The target may be a percentage reduction and may be based, for example, on actualvalues for projects.

Fuel consumption and transport for non-road machinery

As far as possible, when choosing machine tools, the contractor may favour energy-efficient and light-emitting machinery. The procurement of construction materials and land and aggregates andthe planning of telecommunications should aim at reducing transport and related emissions.

As far as possible, the choice of machinery, equipment and transport may favour new machines that are less emission-efficient than the old fleet, quieter and have a lower risk of leaks of fuels and other liquids. The purchase of equipment and transport may be scored on the basis of emissions, noise levels or, for example, the availability of maintenance.

Resource efficiency

The indicators and general objectives for assessing the resource efficiency of the construction of the Kruunusillat project are set out in Table 12.

Table 12 Indicators and general objectives to assess resource efficiency of the construction of the Kruunusillatproject

Indicator	**Objective**
Water consumption (m^3 or litres)	Reduce unnecessary water consumption.
Turbidity and solids (due to dredging): Indicators defined in the“Water Monitoring”/Water Licence Application in the monitoringprogramme	Reduce effects on water bodies during construction.
Total cost ofconstruction materials in tonne-kilometres relative to output (t-km/m^2)	The procurement of building materials will be carriedout with the smallest transport.
Total cost of land and aggregatesin tonne-kilometres relative to output (t-km/m^2)	The acquisition of soil and aggregates is possible-through the smallest transport.
Total amount of construction waste (m^3 or t)	Reduce the amount of wastegenerated in construction.
Share of unrecovered waste in total waste (%)	Sort the waste generated and redirect it torecovery (re-use orrecycling) where possible.

Water consumption and management of water effects

Water consumption on the site typically results from the supply of water at the site base, from on-site casting, green construction and irrigation, as well as from dust abatement measures and cleaning operations carried out in connection with soil compaction.

For major works, the most significant water-consuming works should be identified on a project-by-project basis and ways of reducing water consumption should be defined. It may not be possible to influence allstages of the work, such as the amount of water used for concrete and aftercare.

Water consumption on the site is measured and invoiced according to actual performance. Monitoring of measurement and consumption makesit possible to detect deviations and possible leaks. Water consumption on the site is monitored at the main meter level. The developer may require the contractor to report ondens consumption on a monthly or quartal basis.

The natural flow of water and the infiltration of water into the soil are often hampered by site operations and construction. Rainwater on the site is usually fed into a municipal rainfall in a watersewer. The contractor shall protect rainwater wells, e.g. by means of a filter cloth, so that thesolid does not enter the sewer. Existing street areas are kept clean, e.g. by washingthe tyres of construction lorries before driving in the street area of the municipality. The site must be equipped with anti-pollution equipment against any leaks of on-site machinery.

Purchase of building materials

The contractor will procure building materials on the basis of plans and in cooperationwith the scrutiniser. To a certain extent, the contractor has the opportunity to influence the qualityand origin of the materials and natural resources to be used and to present alternatives to the developerin line with the environment. This requires close interaction betweenthe designer and the contractor during the construction phase. Alternative construction materialsshould primarily meet their technical, functional and qualitative requirements. All changesto the building materials specified in the plans should be approved byagreement between the developer and the designer.

The contractor shall justify the environmental aspect of the non-plannedconstruction materials. For example, the following environmental criteria may be used in the justification:

Alternative construction material/product:

- low negative environmental impacts throughout the life cycle (information on a building on anEPD card, certificate or other equivalent environmental declaration)
- the distance to the site is shorter.
- recycled materials have been used.
- the energy consumption of manufacturing and greenhouse gas emissions are lower.

The contractor shall pay particular attention to ensuring that storage on the siteis minimised and that stored products are well protected from moisture, dust and other nuisances that may render the product unusable and cause further waste and waste. All products shallbe stored in accordance with the manufacturer’s instructions, preferably indoors and on the chassis. In order to avoid, for example, the moisture content of the materials purchased, the stripping rooms-should be appropriately sized in relation to the amount of material purchased.

Soil and aggregates management

For street and park projects in the City of Helsinki, land and aggregates are managed using the S10 table, to which the contractor completes the actual data on the masses to be extracted and needed and the related transport operations.

Any surplus land to be taken away from the site is a resource that should be used in a planned manner in other sites. Virgin soils and aggregates are saved and replaced wherepossible by recycled and secondary materials. The fillings aim at minimising the extraction ofland and making use of material from land or neighbouring areas. The land excavated and extracted on the land is intended to be used for refilling and landscaping. Where necessary,the soils shall be treated on the site in such a way as to meet the low end-use requirements. Refillable soils should be stored and exploited on the land accordingto the mahs.

The land that is decided to be used for construction must be used efficiently and other areas leftnatural as far as possible. The aim is to limitconstruction work to the smallest possible surface area in order not to disturb the topsoil and preserve vegetation to preventerosion. The trees and vegetation remaining on the site are protected for the duration of the works.

The topsoil and growing layers may also be stored in or near the plot and used for construction. This preserves the soil seed bank and avoids the need to source soils elsewhere. The use of the growth layer should be taken into account when planning and recycling the site.

<u>Waste prevention and promotion of recovery and recycling</u>

Waste management on site is based on good planning before work starts. For the bigest projects, a waste management plan is mandatory. Planning can prevent waste generation in line with the EU waste hierarchy. The mass of the site's waste management plan shall be taken into account for the organisation of waste sorting for at least the following waste fractions: clean timber, metal, glass, paper, cardboard, energy waste and construction waste. Before the start of the work, identify the main wastes generated, estimate the quantities and settargets for waste volumes and recovery rates. If sorting cannot be required, post-sortingof building waste is required. The building elements to be dismantled shall be reviewed and the contractor shall oblige the contractor to deliver recyclable materials for recycling in accordance withthe builder's doors.

The aim is to make sorting more efficient on the site by the main contractor by providingan operational framework. Sorting at the site is made responsible for all contractors and forms part ofthe perpetuation. Redirecting waste to recycling or recovery is not only less costly for the-environment, but also cheaper than transport away as mixed construction waste. The recovery of waste as a material is favoured before being delivered to the incineration plant. Appropriate collectionof hazardous waste is arranged on site. The site plan accompanying the tender must take into account, inter alia, the location of waste sorting points and the distances from the work areas. Sorting practices change as construction progresses, but the layout of waste disposalpoints can encourage the right sorting.

The amount of waste generated on site can be reducedby:

- Planning orders in such a way as to reduce the need for and time of storage on the site. Stolenproducts are more vulnerable to damage that can prevent their use.
- By making use of services and products where the manufacturer himself installs his products and commitsitself to absorb the waste generated, they are directly redirected to recycling at the manufacturing plant, thus avoiding unnecessary transport.

Waste volumes and recovery rates are monitored throughout the site by waste segment and comparedto the targets set. The contractor may require the contractor to report well on a monthly orquartile basis for waste volumes and treatment.

3.3.4 Reduction of noise, dust, light and vibration effects

The design of construction works is the starting point for walking and reducing the impact of noise, dust,light and vibrations on the site. The most significant damage-causing stages of work and work are identified, such as demolition, quarrying, crushing,blasting, façade work and plastering. The most appropriate working methods will be selected for the workflows and-INFORMATION to. Particular attention will be paid to the time or time of completion of these works. The constructionsite is isolated from surrounding areas. The lighting of the site shall be applied in such a way asto minimise the adverse effects on the crushing of the fencing. Shredding and crushing work may requirethe use of dust-proofing techniques and equipment.

Traffic and logistics on the site are designed to prevent harm. Roads and routes on the site will be arranged in such a way as to cause as little problems as possible to environmental transport and residents as well as to natural areas. The city's requirements, such as night noise bans, are also respected. Efforts are made to avoid idling of vehicles. Thework is designed and scheduled in such a way that noise and vibration nuisancesare minimised. The need for noise protection is examined on a project-by-project basis. The requirements for theprevention of dust spreading are set out in more detail in the works documents.

Contractors are responsible for ensuring that passenger and material traffic on the site is channelled only throughdedicated routes. Contractors are also responsible for the layout of the site and the construction of protective walls during the construction project. The cleanliness management plan drawn up by contractors should describe the measurestaken to prevent the generation and spread of dust; organisation of on-site transport, subdivision of site sites and dust hail measures during various work phases.

3.3.5 Security

The safety, execution, management and monitoring of construction work must always be carried out in accordance with all laws, regulations, regulations and instructions relating to safety at work.

The construction projects of the City of Helsinki produce a safety document which is a common document of the safety regulations and codes of conduct required by Section 8(2) and (3) of the Government Decree 205/2009 on the safety of the building for the planning and preparation of theconstructionwork. The security management rules and procedures relating to the implementation, asset out in the above-mentioned articles, are set out in the document. The occupational safety document is an annex to the work programme and supplements the provisions on the performance of the technical documentation. According to TR (or MVR-) 2010, the target level of the measurement indek is 85 %/(90 %). The TR/MVR measurement round should include the occupationalsafety officer and the OSH officer.

Table 13 Indicators and general objectives for assessing the safety of the construction of the Kruunusillat project

Indicator	**Objective**
Accidents in connection with construction works	In terms of safety, theminimum objective is to ensure that no serious accidents occur. Youshould investigate all accidents and report to the developer according to the principles of "0" accident.

Implementation of maintenance

The maintenance of the Ruunus Bridges project includes the maintenance of bridge structures, streets and green sites and tracks. Maintenance is defined as a regular activity to maintain the availability and functionality of existing general areas and structures. Maintenance is divided intopick-up and care. Further refurbishment or renewal of sites is a renovation (bridges) or replacement investment (streets) and is not part of maintenance.

In the maintenance of the Kruunusillat project, winter care has a particular importance both in terms of availability andfunctionality of winter time and in terms of maintenance costs. From a cost point of view, the optimisation of the winter management method is of particular importance. The aim should be to choose anadequate desnow method without forgetting the cost of maintenance. The cost management of maintenance is also intrinsically linked to the resource efficiency of maintenance.

An assessment of the sustainability of the maintenance of the Kruunusillat project can only be carried out during the maintenance phase. However, the sustainability elements and indicators presented here can already be used in the designof the screening.

Table 14 Elements of sustainability in the maintenance of the Kruunusillat project

Sustainability dimension	Sustainability component
Economic sustainability	Management of maintenance costs
Environmental sustainability	Reduction of greenhouse gas emissions Resource efficiency
Social and culturalsustainability	Reduction of noise, dust and odour effects

3.4.1 Maintenance costs

The costs of maintaining bridge structures, streets and parks should be taken into account in the calculation of the project life-cycle costs (LCC). The project aims to select methodsof maintenance that are cheap and useful for the entire life cycle of the project. Bridge structures (including light traffic) and tracks are maintained by a different entity. One question then is-whether some of the maintenance tasks can be concentrated on a single service provider.

Particular attention needs to be paid to the choice of winter management methods, as winter care accounts for around 50 % of maintenance costs. The severe winter increases the proportion of winter care as a whole, while at the same time causing more emissions. The removal of snow must be mechanical in most cases, as manual work increases costs. Extremist methods of snow removal include snow centrifugation at sea or snow ploughing, loading and transportation out of the bridge.

Emphasising the usability and functionality perspective may, in some respects, provide additionalsafeguards. This concerns the quality level of operation of the light bus and rail traffic in winter-time conditions. The main requirements for subscribers in winter management are the starting point and intervention time for the removal of snow and ice burns and snow and ice. Theserequirements indicate when the winter care service provider should leave the winter care service and in what time the work should be completed. They also follow the frequency of winter care work and the availability of fairways during winter time.

For other maintenance costs (structures, fittings, furniture, etc.), maintenance costs are influencedby the technical durability of structures and construction surfaces. In some respects, this also relates to the winter management method to be chosen (cf. winter care damage causedby troughs).

Maintenance quality standards and structural solutions have an impact onmaintenance procedures and costs. If the maintenance resourcing does not provide sufficient provision for maintenance quality standards and costs, the use of the transport link may be affected. The quality level is also a selection issue: better quality will lead to more costs andlower costs. Better winter care quality can be found, for example, in increasing the quality standards for Light Route winter care to levels above class A and in implementing scheduled or winter care.

Table 15 Indicators and general objectives for managing the maintenance costs of the Kruunusillat project

Indicator	**Objective**
Project maintenance costs in relation to the level of maintenance quality defined for the project;	Maintenance costs, if any, but maybe reduced to the desired level of quality (cost, EUR)
Resurances for project maintenance inrelation to costs and quality levels	Maintenance managers (HKR, HKL) have provided sufficient resources to carry out maintenance (budgeting/resource, EUR)

3.4.2 Reducing greenhouse gas emissions

An important aspect of the ecological sustainability of maintenance is the energy consumption and emissions of different types of vehicle, machinery and equipment. As only a very small part of maintenance is carried out by hand, almost every maintenance phase takes fuel. Most of the fuel used is diesel and fuel oil.

The most important maintenance products in terms ofemissions are winter care andcleanliness. The bulk of fuel consumption and greenhouse gas emissions are accounted for by snowfall. The level of emissions from maintenance is not constant, but depends on the season and the annual weather conditions. For example, the difficulty of winter (snow, slippage) has a significant impact on the need to use vehicles, machinery and equipment for maintenance. The scarcity and small size of snow farms leads to unnecessary displacement of snow, thereby increasing fuel consumption and emissions. Planning and anticipation play animportant role in maintenance activities and logistics and can influence the level of emissions generated by the activity.

Table 16 Indicators and general objectives for the assessment of greenhouse gasemissions from the maintenance of the Kruunusillat project

Indicator	Objective
CO_2 emissions from transport of materials in relation to output	Reduce the need for transport of materials.
CO_2 emissions from wastetransport in relation to output	Reduce the amount of waste and emissions from waste transport.
Non-road fuelconsumption relative to outputofCO2emissions	Reduce unnecessary consumption and emissions. Purchase of energy-efficient and low-emission machinery.
Ratio of snow transfer CO_2emissions to snow loads ($CO_{2/piece}$)	Reducing fuel consumption and its incoming emissions inwinter management by increasing the possibility of intermediate back-up andmaintaining snow along the streets. Increase load sizes.
Availability of intermediate storage sites: size of the work area (total street area) in relation to snow at intermediate storage sites in the works area (number of snow loads)	Reducing fuel consumption and associated emissions- in winter management. Addition of intermediate snowlashing points to different parts of the work area. The aimis to minimise the value of the indicator so that the intermediate snow storage space is as much as possible in relation to the total surface area of the streets in the work area.

3.4.3 Resource efficiency

The resource efficiency of project maintenance relates to the consumption of materials, structures, equipment,roads, various liquids, chemicals and water, as well as thegeneration of waste for recovery.

The materials used in maintenance are mainly salts and saline solutions used for the prevention of slippage. Other materials include low-use asphalt masses, Murs ketsand edge subsidies, which contribute marginally to the maintenance of the project. Chemicals used inmaintenance are, as a rule, pesticides. The ground and kids used formaintenance include the sanding basket and the ash used in summer.

The water consumption for maintenance consists, for the most part, of street washing water. In maintenance,the kids are washed, among other things, for washing the dust formed by sanding sands,and for cleaning. Water is also used for irrigation and water-related purposes. The water used for maintenance is taken from the water supply network as, according to the EEA, river/lake water must not be used for street cleaning due to its potential contamination.

Maintenance wastes consist, inter alia, of municipalwaste cleaned during cleaning and plant waste generated during maintenance (leaves, cutting and cutting waste). At present, the environmental reporting of works does not distinguish between waste produced by the communityand generated by maintenance activities. For example, metal waste includes metal waste collected from streets, such as car exhaust pipes as well as metal waste generated in connection with maintenance activities, i.e.broken road marker columns and means of binding goods loads. It isworth noting that, for example, landfill waste includes waste collected from general waste receptacles in the works area.

Table 17 Indicators and general objectives for assessing resource efficiency of the maintenance of the Kruunusillat project

Indicator	**Objective**
Total consumption of materials and substances (tn or litreraw) in relation to ha-selected maintenance quality	Carry out the works with aminimum quantity of materials and materials, while achieving the desired level of maintenance quality.
Water consumption (m^3 or litre) to the-desired level of maintenancequality	Reduce unnecessary consumption.
Total amount of waste generated in maintenance (m^3 or t)	Reduce the total amount of waste generated by maintenance activities
Share of unrecovered waste in total waste (%)	Sort the waste generated and redirect it torecovery (re-use, recycling or incineration) where possible.

3.4.4 Reducing noise, dust and odour effects

Maintenance activities result in noise, dust and odours effects, thereby affecting the comfort ofthe area, human health and well-being.

The monitoring of air quality in Helsinki is based on EU limit values. The limit value for inhalable particles is exceeded if the daily concentration exceeds 50 $\mu g/m^3$ for more than 35 days per year. Seasonality of 50 $\mu m/m^3$ corresponds to satisfactory air quality. The seasonal guide value is 70 $\mu g/m^3$, which may be exceeded once a month.

The dust content of streets is partly due to maintenance activities, as the sanding sand used for winter management causes dusting in spring. Dust fixation, street washing and sand extraction are part of maintenance works (winter care and summer structures). It is therefore a significant environmental impact that can be managed through maintenance. On the other hand, the snow crunch and displacement cause significant harm to the inhabitants of the area as noise increases. However, noise is not a very significant handicap for the carunus, as there are no apartments in the very vicinity of the bridges.

At present, the noise and air quality impacts of an individual maintenance work cannot be measured well inan environment of multiple sources of noise and air quality. However, in the case of competitions for the overhead maintenance contract, thecomfort factors can be influenced by favouring low noise machines (e.g. electric machines) and working methods that prevent noise and dusting.

Table 18 Indicators and general objectives for the assessment of the noise, dust and odour impacts of the maintenance of the Kruunusillat project

Indicator	Objective
Exceedances of the PM10 limit value for air (number of days exceeding the daily street dust value of more than 50 µg/m³)	Improving the comfort of street areasby reducing the amount of dust. The indicator should therefore be kept to a minimum.
Users return tomaintenance and mark	Users shall be provided with feedback on maintenance activities, including the noise and odour effects of maintenance. If returned,you should be as positive as possible. Feedback received will be responsive toother possibilities and the maintenance activities will be continuously improved.

3.4.5 Security

Maintenance operators shall, through their own processes, ensure the safety of users of the transport connection during the maintenance work and the safety of the workers responsible for the maintenance. Information onsafe mouths (e.g. information on slippages and poor visibility) may be takeninto account at the project design stage (screens on both sides of the bridge, etc.) and is constantly being developed, e.g. on the basis of user feedback received.

The safety aspect is also related to thesafety of substances used for the maintenance of the transport link. In the case of plant protection products, the selection of substances that do not causeharm to the environment and humans is sought. For example, glyphosate-based substances have been estimated to causeharm to plants, humans, animals and soil. Mechanical working methods may also be preferred over chemical substances.

Table 19 Indicators and general objectives for assessing the safety of maintenance of the Kruunusillat project

Indicator	Objective
Accidents in connection with maintenance work	Maintenance contractors and service providers have safety-related processes in place (safety instructions and training, safety planning, safety related equipment and monitoring of accidents at work). Safety-related information shall be developed and used.
Use of plant protection products	The use of plant protection products based on glyphosate, which are harmful to plants and other natural resources, is restricted, with the aim of using e.g. acetic solution or mechanical working methods.

4 Follow-up recommendations on planning

4.1 Traffic planning

4.1.1 Transport solutions

Connecting to stops and stations is an integral part of the public transport system. At theend of the LAA, in order to improve the accessibility of thesystem, pedestrian and cycling links shall be ensured throughout the line. For bicycle parking, coveredand centralised solutions are recommended close to stop platforms in both the Broadtail and Sompa Islands. Attention should be paid to accessible walking links on the periphery side of the city, but pol-bridge parking is also recommended close to the base city stops.

Walking and cycling are more easily connected tothe rest of the region's transport network. At the western end of the bridge, connection to the existing walking and cycling network is clearly organised in the Hakaniemi option, but in the case of Kruunuha, the transversal connection to the west of Liisankatu requires more action. It is important to considerthe smooth and secure connection of the Kruunusillat cycling network to Helsinki's future Banana network in all the-conditions of the convenience of the city. On the bridge itself, the dimensioning of the traffic technology is related to the smooth running and safety of movement.

With regard to the rail network, the Hakaniemi option may consist of a bottleneck of the capacity of the long-termbridge, which is already running between 25 and 30 trams per hour intheir direction, and according to the line plan 2014 (HSL, draft of 17 March 2014), wagons with at least the same density.

4.1.2 Ensuring fluidity of traffic

Roughly half of the new tram passengers come from car users and the other half from walkers and cyclists. This in itself facilitates the smooth running of car traffic by slowing down the growth of car traffic.

The number of walkers and cyclists on the bridge is forecast at 3000 users per day (Strafica 2013). The promotion of cycling and the increased popularity of cycling, as well as the widespread use of e.g. electric bicycles, are likely to increase both the number of cyclistsand the average cycling season. Light-weight electric motored mobility devices, whichare similar to pedestrians, are also expected in the future, with a slight difference in space from pedestrians. Although the cross-section and capacity of a typical quality track is sufficient for walking and cycling, desnow in winter may result in users sufferinga sense of safe snow and comfort.

Difficult weather conditions set their own requirements to ensure the smooth runningof traffic. Darkness, obscurity and fog lead to the need for smart lighting adapted to the situation. Wind intensification can be partially offset by wind protection barriers. The bridge deck'sslip during the season or exceptionally heavy winds can be communicated on smart panels or other real-time systems.

Social security, monitoring systems and general cleanliness as such improve the acceptability and usability of a long bridge for different user groups.

4.1.3 Ensuring the functioning of transport

Winter management of the Kruunusillat project will be the main challenge for transport efficiency if the effects of climate change are predicted to materialise. Walking and lying connectionsto stops, snow off the bridge (trackway, walking and cycling) and the slide torn mustbe adapted to the need. Proactive smart policy guidance is a prerequisite for ensuring thefunctionality of the field and the attractiveness of the bridge.

The connection of the new tram line to the network of the centre with transmissions also presents additional challenges, including winter care. On the network, a single problem situation is rapidly reflected in a large area.

4.2 Bridge design

Maintenance and reparability of structures:

- Pre-planning of repairs and bundling of connected refurbishable building blocks at the same time for renewal
- It is planned to carry out repairs in such a way that the link is at least limited for the durationof the repairs;
- Consumable structures: designed to be renewed, renewed and repaired as easy as possibleand financially as possible
- The bridge is planned to be maintained in such a way as to minimise adverse effects on the submarine watercourse and on the bird in the protected area (e.g. under the bridge by meansof a spring head).

From an overall sustainability perspective, the potential effects of climate change should also be taken into account in the planning process. Consideration of these effects is summarised below. The impact of climate change on the Kruunusillat project (Ramboll 2015) has been discussed in more detail.

Durability of reinforced concrete structures:

- Specific design attention shall be given to concrete tipping, as drift affects both chlorides and carbon dioxide intrusion into steel concrete structures.
- The protective concrete coatings of reinforced concrete structures shall be similar to those of thecurrent instructions. No overshoot can be allowed.
- The use of stainless welded steels shall be considered as far as possible. However, they shall be insulated by plastic connectors from conventional irons.
- Particular attention to structural management and repairs to structural protection

Protection against corrosion of other structures:

- As regards corrosion of steel structures, account must be taken of the effects of climate change on maintenance intervals and painting systems.
- Special attention shall be paid to the protection against corrosion of sparkling cables (lifespan 80 years)
- The corrosion capacity of the loops shall take into account a lifetime of 200 years, soils with sul-fidisave and chlorides shall be taken into account in the choice of materials.

Water management:

Planning shall take into account the discharge of water from the bridge deck and structures. Explain inmore detail how rainwater is discharged into the sea. Examine whether the bridge’s ve-depletion systems are adequate in relation to the predicted increase in rainfall. Special attentionto the need for sufficient capacity, conduits and drops of conduits

- Design shall take into account how to prepare for heavy rainfall (railway wells and number and layout of the pipes) for the drainage of the bridge;

Other:

- The design shall take into account the build-upand drying of structures due to changes in sea level levels and the variation of temperatures on both sides of the sea. This must be more precise,e.g. with regard to the choice of superstructures.
- Vegetation should not be attributed to bridges. The effects of vegetation on beach structures must beirrigated (e.g. the need for root protection);

4.3 Street and park planning

Maintenance and reparability of structures:

- It is a requirement for roadside structures to accommodate water supply, energy transmission ron and telecommunications wires, cables, etc. (InfraRYL). The better preparing forfuture needs in the mid-stage and the less the installed wiring, etc. require maintenance, the less the need to break the overhead layers during operation of the structure.
- Land interfaces can be pre-designed to avoid stripping and rebuildingof street coverings
- Design different types of cables, cables, etc. next to the street, where possible, so that the street does not need to be opened unnecessarily due to their maintenance;
- The maximum useful life of cables, cables, etc. placed under the streetreduces unnecessary street opening.

Resource efficiency:

- Planning can be steered in such a way as to leave as little natural land as possible under street structures.
- The solutions presented during the planning process should be assessed from a resource efficiency perspective. For example, some of the resource efficiency indicators presented in this report can be used (chapter 3.2.4).
- The design principles may include an objective to enhance the use ofsoils and substitutes, for example.
- Planning guidance needs to be given more attention than traditional mouth mowing,as the design of a resource-efficient solution differs from the traditional requirements, solutions or materials used in the Infra- RYL:ssä requirements.
- Natural storm water solutions can save the amount of rainwater discharge: in addition to plumbing and mine materials, inter alia, the bottom reinforcement and construction of pipes.
- The criteria for deflection and recovery of parks could be rather broad in those parts of the park where the depressions and sweeps are not relevant to the functioning of the structures.
- For example, recyclable asphalt could be used to a greater extent under the consumption layer and to cover intermediate storage fields. The use of a reinforced-bench, e.g. in a dividing layer, produces an overhead structure that is more rigidthan rupture by normal crushing, resulting in a lower end of the coating deformationand a longer life span of the coating.
- In order to maintain the soil’s carbon stocks, the topsoil coating techniques, which preserve the soil layer, can be used and the layers are not mixed.
- The construction schedule is designed to allow wet soils (e.g. clay, siltti) to dry for a sufficient period of time to reduce the use of cement tostrengthen the substrate.
- The ecosystem services perspective can be used in planning. This perspective will strengthen the delivery of holistic, sustainable developmentgoals and the maintenance of ecosystems. The inclusion of ecosystem services in fairway management and

transport has been further explored, inter alia, in the Transport Fact Sheet (2011).

4.4 Construction

The project should be subject to site-specific environmental plans. Buildinghank's-environmental plan is a description of the environmental measures on the site and is intended to assist the site manager in managing the environment. The overallplan aims to reduce the environmental impact of constructionactivities. The site environmental plan shall be drawn up and submitted to the developer before theconstruction works begin. The environmental plan shall take into account project-specificrequirements and environmental characteristics. The environmental plan shall also assess the risks that may be activated during the various phases of construction.

The drawing up of an environmental plan for the site should already be taken into account in tendering for works. As an annex to the tender, the contractor will be asked to submit a draft environmental plan for the site. In the invitation to tender, the contractor shall describe the substance of the environmental plan and check, when comparing the tenders, that the contractor's plan meets the content requirements.

The contract terms of the works shall include the condition that the contractor reports periodically on awide range of environmental management of the work. The reporting requirement is important in order tomonitor the implementation of the environmental plan. The reporting shall specify the different stages of work, such as the demolition phase in its own phase. The developer may determine the information to be reported on a project-by-project basis. The reporting will be complemented as the works progress and the implementation of-the environmental plans will be regularly monitored at site meetings.

4.5 Maintenance planning

A maintenance plan should be drawn up for the project, including principles forwinter care, structures for maintenance and maintenance, maintenance and maintenance of equipment and furniture, clean-up, vegetation and maintenance, management and maintenance of equipment and systems. The plan should take into account the economic, environmental and social sustainability of maintenance. The maintenance plan shall be drawn up at the same timeas the bridge design and the street and park design and shall ensure the communication of information betweenthose responsible for the design. The design and procurement of bridge structures should take into account the maintenance requirementsof the fields. Post-construction maintenance shall follow the lines chosen for the original design. Maintenance managers shall ensure that the implementation of the maintenance plan is regularly monitored at the site meeting of the workareas.

Project maintenance planning should also take into account the potential effectsof climate change. The impact on maintenance has been discussed in more detail in the study on the impact of climate change on the Kruunusillat project (Ramboll 2015).

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Annex 1 Hakaniemi — The overall sustainability of the preliminary master plan

This looks at the overall sustainability of the Preliminary Master Plan of the Kruunusillat project Hakaniemi-Nihti. Three options can be considered:

- Direct bridge
- Artificial Island and Bridges
- Minisaar and bridges

The elements of sustainability in the design of the Kruunusillat project are presented in the-table below. Investment costs are excluded from this analysis as they are calculated separately. It is essential to bring other sustainability factors into a comparison of options alongside costs,-or facultative factors.

Elements of sustainability in the design of the Kruunusillat project:

Sustainability dimension	Elements
Economic sustainability	Investment costs Lifespan of structures Maintenance and repairability of structures
Environmental sustainability	Resource efficiency Maintenance of ecosystem performance

Socio-cultural sustainability	Using local experience and know-how to develop urban images and to celebrate cultural heritage

Summary of the evaluation

Economic sustainability

Rail and light traffic consumes much less on the street pavement than on drivingadvice. The natural stone is very long-lived, in particular natural stone from thearea close to the project. The asphalt will have to be renewed. Asphalt's average need for sweeping is reduced by the absence of vehicle traffic on the street (excludingmaintenance driving). The coating on the bridge is not exposed to crushing.

Environmental sustainability

The highest CO2 emissionsfrom building materialsare dueto the completion of concrete structures. In*the case of artificial islands and bridges and the Mini-made Island and Bridges,* the consumption of bridge structures is of the same order of magnitude. In these options, less concrete structures are needed than the *direct bridge*.

In the archipelago options, fillings (minimum fillings and green growth layers) are almost double the number of *direct bridge* options. Land and aggregates consumption is highest in the case of *artificial islands and bridges*. The conditions under which dredging masses and contaminated dredging masses are removed from the area. More detailed planning could explore the possibility of stabilising dredging masses and using them for the implementation of islandoptions vi wheas, which would reduce emissions from the transport of land and aggregates.

The*Artificial Island and Bridges* option allows for the creation of a new habitat in an already-stretched urban environment. *A direct bridge* is thebest option for maintaining the ecological status of the water. Under this *option, artificial islands and bridges* can be used forwater management and different delaying solutions can be envisaged for the green area.

Social sustainability

The*'Artificial Island and Bridges*' option will more effectively link other options for the construction of a new residential and job area in the Hana Islands to the existing urban structure and part of the developing eastern metropolitan city. The*'Artificial Island and Bridges*' option will locally increase the green spaces ofMe riha and the Hakaniemi area and recreation opportunities in the already urban urban environment.

1. ECONOMIC SUSTAINABILITY

Lifetime of buildings

Indicator	**Objective**	**Hakaniemi-Nihti Preliminary JS**
Useful life of the main building blocks of the	100-200 years	100 years
Useful life of the current parts of the bridge (Vedeneris roads, motor seams and edge beams)	40 years	30-50 years
LCC/life (EUR/year)	The project must be economically viable overthe long term;	*Costs are calculated separately*
Carrying, dividing and leaching layersof dat	40 years/to be defined by project (InfraRYL 2006)	The required service life of the street constituents is set out in InfraRYL2006 in the performance requirements of the street structure (the table shows the lifetime requirement for some building elements); The design of street structural layers (e.g. split ros) has the potential to influence the useful life of the overhead structure, which has a direct impact on repair and renewal needs (e.g. less deformation of the topte on more rigid layers). It is also necessary to take into accountthe future effects of airborne trench change in the lifetime anddurability of ground structures. The increase in individual heat periods increases the warming of the asphalt layers of the street. The warming ofAsfal tin can speed up the lysise of the street wall. As a resultof increased rainfall, street structures are more frequent and longer thanbefore. The grooveing (deep depth) of the streets can double with an increase in the watercontent of the superstructure of about 2 %. As a result, the-working lives of streets can be significantly-
Street pad wall andbells	100 years	InfraRYL 2006
Street ground structures and ground reinforcement (pain and pile construction, pillar and massastabilisation)	100 years	InfraRYL 2006 The choiceof bottom construction/base-confirmation method (e.g. ballast/pillar stabilisation/lightening) can influence the in-use deflections of the ray and theneed for correction due to stomachdeflections

Maintenance and repairability of constructions

Indicator	**Objective**	**Hakaniemi-Nihti Preliminary JS**
Useful life of street covering (AB, natural stone, concrete stone)	To be defined by project	Street coverings with natural stone and asphalt
Streetoverheads lifespan	30 years/to be defined by project (InfraRYL 2006)	In accordance with InfraRYL 2006 Natural stone is a very long-livednatural stone, in particular natural stone from the perimeter of the project. The asphalt hasto be renewed. Asphalt's average need for sweeping is reduced by the fact that there is no road traffic on the street (excludingmaintenance driving). Rail and light traffic consumes considerablyless than vehicle traffic than thepavement of the street. The coating on the bridge is not exposed to crushing. Under the *alternative option, the artificial-island and bridges* Hana Island Bridge will slightly increase the volume of light traffic compared to otherconditions.
Lifetime of technologies underthe street (hill watersewers, etc.)	50 years of new padding during therecreation of thetea on the top of the street	The technology shall be renewed when the overhead structure of the street is renewed.
Maintenance and repair-charge (EUR/200years)	Maximumman's low maintenance and repair costs duringthearch life of the project	*Costs are calculated separately*

2. ENVIRONMENTAL SUSTAINABILITY

2.1 Resource efficiency

Building materials

Indicator	**Objective**	**Hakaniemi-Nihti Preliminary JS**
Hard-world consumptionof building materials (m^3) taking into account the desired service level	Implement the project as little as possiblein terms of material and achieve the desired service level;	The table below shows the consumptionof main materials by option. Construction materialsand the highest $CO2_{emissions}$are caused by-the manufacture of concrete-structures. This is mainly due to emissions fromcement production. In*the case of artificial islands, bridges and mini-made islands and bridges,* the consumption of bridge structures is of the same order of magnitude. Under these options, theneed for concrete fields is lower than for the *direct bridge*. Steels and the wear of piling-structures are the same for all options. Sister exchange documents require almost twice the number of *direct bridges*.

Material (structural component)	**Material**	**Direct bridge S3**	**Artificial Island/Minitekosaari**
Concrete(s)	C30/37-3	1 585 m 3	1 138 m 3
Concrete (land payments)	C30/37-3, P30	1 169 m 3	1 377 m 3
Concrete (transition tiles)	C30/37-3, P50	55 m^3	130 m^3
Concrete (Cansi/Balconic	C35/45-3, P30	5 200 m 3	1 261 m 3
Concrete (Bear beams)	C35/45-3, P50	152 m^3	65 m^3
Concrete (mills/intermediate	C35/45-3, P70	368 m^3	342 m^3
Reinforcing bars and rods	A500HW	1 004 466 kg	408 007 kg
Flat steel (middle bridge)	SFS-EN 10025—	300 000 kg	300 000 kg
Steel tube beams	EN 10219—	15 000 kg	15 000 kg
Pickling RD220, t=10.0 mm	S355J2H	0 m	165 m
Pickling RD600, t=14.2 mm	S355J2H	0 m	84 m
Pickling RD800, t=14.2 mm	S355J2H	2 177 m	1 648 m
Quay/beach wall demolition		2 000 m 3	2 500 m 3
Bridge cleanings		1 290 m 3	1 290 m 3
Terraces			31 m^3
Fillings		3 690 m 3	6 310 m 3

CO_2emissionsfrom the scrubbing of building materials	To carry out the-purchase of the mah-dolls by means of minimum transport.	The origin of the materials is not yet known. Emissions from transport of building materials typically account for only around 3 % of the emissions caused by theproduction of materials. However,-the transport of balsin construction paints causes significantly higher emissions than the passages of e.g. land, stone or buildingwaste. This is mainly due to thelong journeys of materials importedfrom outside countries. For example, the country of origin of the naturalstones has a significant impact on transport emissions (7 kg CO_2e/tonne of stone withinFinland versus 350 kg CO_2e/tonne of stone from China). Sourcing of materialsmay take into account the origin of the materials and, when scoring materials/products, favour those with lowerCO_2emissions fromtransport.
Share of recycled materials in total material consumption (%)	Replacing the use of-non-autonomous natural resources by means oftertiary recycling in such a way as not to increase the-entire female consumption of materials.	Not yet known. The proportion of recycled materials varies according to materials and between material-readyers. For example, in concrete, the proportion of recycled materials depends on whether the concreteis produced with a partially crushed old concrete, and whether fly ash or virgin substances are used as an additive for cement. A large proportion of steelstructures account for 100 % of recycled material. More detailed planning may explore-the possibility of using recycled-materials, e.g. in street structures (concrete burst, etc.).

Soil and aggregates

<table>
<tr><th>Indicator</th><th>Objective</th><th>Hakaniemi-Nihti Preliminary JS</th></tr>
<tr><td>Total consumption of land and aggregates imported (m³)</td><td>Carry out the project with thehighest possible consumption ofsoil and aggregates.</td><td>Wet fillings and greenfield growth layers are needed for the implementation of the reconstituted islands and bridges, as well as the M Insularand Bridges options.

Land and aggregate consumption is highest in the Teko island and bridges option. The streetstructure layeris the same incats with the samealternative.

The table below showsthe total consumption of land and aggregates imported into the region under the conditions for</td></tr>
<tr><td><table>
<tr><th>Soil and aggregates</th><th>Artificial Island</th><th>Miniteko Island</th></tr>
<tr><td>Trap fillings</td><td>690 000 m 3</td><td>510 000 m 3</td></tr>
<tr><td>Green area</td><td>2 100 m</td><td>650 m³</td></tr>
<tr><td>Low gra-nit wall</td><td>1 100 m</td><td>133 m</td></tr>
</table></td><td colspan="2"></td></tr>
<tr><td>CO2 emissions from the transport of land and aggregates entering theregion</td><td>Carry out the project with thesmallest possible means of transporting soils and aggregates;</td><td>The origin of the earth and aggregates is not yet known. Transport distances for Penger/section masses typically range between 30 and 50 km, with astreet covering of 20-30 km.

In terms of the consumption of soil andaggregates, transport hasan insignificant effect.</td></tr>
</table>

<table>
<tr><td></td><td></td><td>these distances should be taken into account in the s10-table of the City of HelsGi(HKR) s10 to be drawn up during the street and park mouthing phase.</td></tr>
<tr><td>Total number of defects to be transportedout of the area (m^3)</td><td>Select the construction ofthe ground building in such a way that the construction releases thelow quality residual soiland the required good-quality friction to a minimum,e.g. e.g. e.g. e.g. to fill intheground rocket with mass exchange dos. Treat the resulting surplusesof roe so that they can be exploited on site. The treatment may be e.g. buckling, screening, massstability, etc.</td><td>Dredging mass and contaminated dredging masses are removedfrom the area. The table below shows the number of massesto be taken out of the area in the ‘ artificial Island’ and ‘Ministry’ options.</td></tr>
<tr><td><table>
<tr><td>Soils to be removed from the area</td><td>Artificial Island</td><td>Miniteko Island</td></tr>
<tr><td>Dredging</td><td>440 000 m 3</td><td>305 000 m 3</td></tr>
<tr><td>Pima — dredging</td><td>40 000 m 3</td><td>15 000 m 3</td></tr>
</table></td><td colspan="2"></td></tr>
<tr><td>CO_2emissions from the transport of land and stones to be transported out of the area</td><td>Avoid water for the transport of land and-stone materials.</td><td>The site for the treatment of contaminated dredging masses is not yet known. Contaminatedland from HELSing’s construction works is delivered, by pollution category,to various backfilling points (typically Forssa, Salo, Porvoo, etc.).</td></tr>
</table>

Percentage of imports of virgin earth and aggregates (%)	Reduce theuse of faults inthe non-negative list andreplace them with-surrogate and recyclablematerials. Dynamism ofthe surplus of the nearby sites and of thedefectsin the building.	The origin of the masses is not yet known. The origin of the masses is determined by theexactmass of the design (s10 table). The design meansthat it is possibleto ensure that the consumption of naturalten soils is the lowest possible and thatthe surplus of rot and aggregates from other constructionsites in the mainurban area will beused in-construction.
Share of surplus land and aggregates diverted for recovery, out of land and rocks (%)	Control the usefuluses (e.g. from another constructionproject)of the excess ground and defects inthe building.	The beneficial use of earth and aggregates is not yet planned.
On the site for use anduse soil and aggregates as a proportion oftotal gland (%)	Exploitation of land-generated excavated-land in construction (e.g. in fillings). In the caseof a TAR, the interim storage of theexcavation is planned in advance.	The beneficial use of earth and aggregates is not yet planned. A more detailed swallowingof the mouth makes it possible to identify the possible mouth to-stabilise the dredging masses and to use themas *a* pre-marking *of* the 'artificial archipelago' and 'Minitekosaari' green areas. The efficient use of land masses reduces the consumption of land andaggregates imported into the region and their transport of-

2.2. Maintenance of ecosystem performance

Indicator	**Objective**	**Hakaniemi-Nihti Preliminary JS**
Land use change by land use category, %	The planning solutions aim to use the land inan efficient way and to keep it aspossible to a non-native nature. Planning can also create newhabitats in the environment that increase the multiformity ofnature.	The land use category of the site will not change as a result of construction. The design is based on further construction andthe condensation of the urban structure and partlythe use of solidinfrastructure. The*artificial archipelago and bridges* option makes itpossible to create a new habitatin an already built-upticks environment. The*'Artificial Island and* Bridges' option links the construction of anew residential and job area in Hana Island with a sharper power than other alternatives to theexistingurban development.
Ecological status of surface waters, classification	The design solutions aim at maintaining or improving the ecological ecological status of the surface waters ofthe project area. As partofthe snow, you plan, among other things, the city's stormwater strategy to identify the-drainage and delaying patterns of storm water forming in the area, to takeaccount of the space reservations they require and to draw upa plan for the stormwater	A flow-consulting has been carried out in the scheduling area. Onthe basis of this analysis, the option of *a direct bridge* is the best option for-maintaining the ecological status of the water. The effluents are intended to be diverted directly from the bridge to the sea. Artificial *Island and Bridges* green spaces can be used forwater management and different types of delay solutions can be designed for the green area.
Nitrogen and phosphorus emissions	Planning solutions aim to-prevent or reduce-eutrophication in water-bodies.	The plan favours low-emission mobility and reduces emissionsfrom one car car. Under this *option, the* management of green spaces (e.g. grass fertilisation of-fields) may lead to an increasein emissions to the water body, which should be taken into account in the maintenanceplanning.
Noise areas (above 55 dB) and number of people exposed	The design solutions aim at reducing the noise generated by the project. Noise affects	The noise generated by tram traffic is increasing on the Hakaniemi coast, which needs to be taken into account in furtherplanning. Time of

	animals, such as bird species practice and other natural habitats, also haveland-use grubbing--up.	the noise of the nose shall be taken into account in the construction site arrangements.
Turbidity and solids		Dredging causes temporary turbidity of water. The disadvantages maybe mitigated by, for example, timing dredging worksoutside water ecology or water for recreational purposes.
Dust		Dust nuisances may occur during-construction, which needs to be taken into accountin site layouts.
Vibration		The vibrations caused by tramway traffic increase on the Hakaniemi coast, which needs to be taken into account furtherin planning.

3. SOCIO-CULTURAL SUSTAINABILITY

3.1 Making use of local experience and knowledge

Bridge, street and park planning are based on the planning principles and practices ofthe city of Helsinki. The planning will take into account the current circumstances of the area and the tacticalcharacteristics of the city. One*of the reasons for the 'Artificial Island and* Bridges' option is to increase local green spaces and recreation opportunities in Meriha and Hakaniemi in the urban environment. The design employs Finnish planning agencies. Local experience and know-how are used, for example, to manage soil and aggregates. Local mass co-ordination allows the project to exploit surplus countries from other buildingsites in the neighbourhood.

3.2 Developing urban images and safeguarding cultural heritage

The Hakaniemi-Nihti bridge will create a new urban environment between the decommissioned urbanarea and Meriha/Hakaniemi. The link is part of the wider Kruunusillat project, which links the maritime districts of the east to thebuds. The Hakaniemi-Nihti Bridge is located in a highly changing urban, land-use and functional environment. The construction of the Nihdi areawill start in the early 2020s and the implementation of the top of the Hanasaari will start in 2025. The construction of these areas has a greater impact on the urban image and the large landscape of the area than theHaka niemi-Nihti Bridge options. The area as a whole is transformed from the areas affected by theactivities of the power plant and the port into the everyday environment of the Helsians, and thenewly existing beach area will increasingly become part of the living environment of the inhabitants of the eastern metropolitan area.

The 'Artificial Island and Bridges' option also effectively links Hanasaari to the developing eastern metropolitan city. In particular, the Head of Hanasaari will benefit from this option by reducing the journey to and from Hakaniemi to and from the Helsinki Core Centre by more than 1 km. A tramway stop in the connection area between the Hana Islands and the artificial island and the new bridge will help improvetransport connections for future Hana Islands and support the recreation of the artificial island.

Annex 2 Total sustainability of the Nihti-Cruun Mountain section

This looks at the overall sustainability of the design of the Nihti-Kruunu Mountain Bank section of the Kruunusillat project. The following have been used as a starting point for the review:

- Nekhti-Kruunu Mountain General Plan
- Urban public transport connection to the mountains, town plan
- Kruunus bridges, Nihti-Kruunu Mountain Bank, Application under the Water Act

The elements of sustainability in the design of the Kruunusillat project are presented in the-table below. Investment costs are excluded from this analysis as they are calculated separately.

Elements of sustainability in the design of the Kruunusillat project:

Sustainability dimension	Elements
Economic sustainability	Investment costs Lifespan of structures Maintenance and repairability of structures
Environmental sustainability	Resource efficiency Maintenance of ecosystem performance
Socio-cultural sustainability	Using local experience and know-how to develop urban images and to celebrate cultural heritage

1. ECONOMIC SUSTAINABILITY

1.1 Investment costs

As part of the project plan for the bridge, the costs of implementing the urban development plan will be accounted for separately and will be presented to the City Council in the context of the project decision. In general, the construction of the bridge has positiveor positive effects on the image of the Kruunu Mountain Bank, the price of the plot of land to be built there and the marketabilityof the apartments in the pre-leave area and, consequently, thetimetable for the construction of the area. By improving the accessibility of a well-functioning public transport and metropolitan city, the attractiveness of the entire Broadsalo as a residential area, e.g.for those working in the metropolitan area, will increase.

1.2 Lifespan of structures

The design life of the Crown Bridge is 200 years, during which time the hard-to-renewal load-base components must be maintained. These include bridge flats, pilons, lid bearing steel structures and a deck plate for the section of the cable. In the caseof steel constructions, the life expectancy requirement introduces special requirements for fatigue. The 200-year working age requirement is very challenging for concrete structures due to the maritime conditions of the bridge. The stability of concrete structures is threatened by the intrusion of chlorides into concrete, carbonate deposit, repeated melting/freezing and ice in the water range. Achieving the 200-year lifetime target requires careful work and well-selected, high-quality materials.

In addition, specific structural solutionsand/or safeguards are needed for the most heavily burdened building blocks. In the design, the main measure to safeguard thestability of concrete structures is the definition of minimum characteristics to achieve the required service life. These characteristics are: the strength of concrete, the P number, the maximum water to cement ratio, the minimum cement volume and the minimum value of the concrete cover have been defined in cooperation with the leading expert on bridge concretes in our country. In addition, the most heavily stretched components have been identified which, for their stability, require coating, protective shells or the use of stainless concrete coatings. The above-mentioned measures are recorded as requirements in the Bridge Design Criteria.

1.3 Maintenance and repairability of structures

At both ends of the bridge there are undercut points for light traffic and service traffic. The 'shared space' principle applies at the tramway crossing point andelsewhere in the Mischa and Mascha Square: at one crossing, maintenance, walking and cycling are arranged on the southern side ofthe tramway. The principle is that all operations in the square are at the same level. Room is provided for the rescue and rescue drive in the square. A road and maintenance road to the High Island has been presented tomeet the requirements of the tap. Its dimensions also take into account the space requirements of the combined vehicles.

The surface waters of the bridge deck are discharged into surface water pipes from which the waters are dropped directly into the sea. The lid shall also be equipped with drift pipes. Civil engineering pipes and wiring placed on the bridge are placed under deck on cable shelves to be installed between the main support beams. The establishment ofthe coukkoli tea connection will enable the construction of large infrastructure links between the districts of the city, which will improve the security of service use, in particular in the Kruunu Mountain, the Large Strait and also in the High Islands.

The bridge shall be equipped with a mobile, reversible care bridge running over the entire lengthof the deck on rails to be installed between the main supports. In Pylon, a gauging- (rotary, ladder) is arranged from deck level to cable anchors and flight safety lights. Illumination doesnot take account of their comfortability in all circumstances.

The bridge shall be equipped with a monitoring system. The purpose of the monitoring system is to ensure the planned implementation and operation of the bridge during the construction of the bridge, to monitor the operation of the bridge during its operation and to obtain information on anomalous events on the bridge, and to produce and archive the bridge's in-service information for maintenance and maintenance. You will besubjected to alarm limits and notifications, e.g. a watercourse leak detector (Finkens). The aimof mouth mowing shall be as open as possible and the sensing type used shall be of low reliability and, where possible, easily interchangeable.

The monitoring system has provisionally included:

- Migration measurements (surface construction, pylone, physical welds and sleeping devices)
- Meteorological station (wind + other meteorological information) and camera monitoring
- Elongation sensors for steel structure and welded steels (drift, fatigue, long-term deformation)
- Temperature measurements of the structure and leak detectors (pipe installation, deck v insulation integrity)
- Corrosion sensors and reference electrodes
- Vibration measurement (ropes and bridge deck)

2. ENVIRONMENTAL SUSTAINABILITY

2.1 Resource efficiency

For general design, a number of press, reflector, vibration and drill drills, printing and wing diseases have been used in the past from the bridge. In addition, soil samples have been taken to determine the geotechnical characteristics of soil species and pilot wells for pollution studies have been carried out. In the context of the general plan phase, thebridge site will have been carried out in 2014 as complementary studies on press reflector, drill and wing diseases.

The Bridge of the Kruunu Mountain Bridge is located in the soft window on the west and east of the bullets of thename 'male and mother'. The shore of Nihdi is, in the case of planned land support, an area filled into the sea. The planned tram line is located on existing land in the northern part of the High Island. On the basis of bottom survey data, the soils of the area consist of the top filling layer and a clay layer of approximately one metre thick in some places.

The beach wall of the Aallonhalja (former Sörnian Pier) on the eastern side ofSompa Island is pitched eastwards of a berth of about 10 m old. The first section of the Rantamuur (approximately 30 m) is built on a pile plate. After the Paalulaatta section, the beach wall is designed to be set up on a quarry bench. Dredging mainlyof soft sediments and clays is carried out at the level of the Louhepe kernel. The root of the ironwall is fitted with a protective plate against erosion.

In the southernmost part of the Kruunu Mountains, the island of doira in the area of the former oil port is to be extended to the maritime area. Before construction starts, dredging and sea filling shallbe carried out in the area. The total mass to be dredged is approximately 550 000 m 3. Based on the sediment studies carried out, some of the encroachments of the sediment designed to be dredgedcontain elevated levels of harmful substances. It is estimated that approximately1 200 000 m 3 filling masses are needed for construction. Filling materials are presented for the use of quarry, friction earth or concrete. Concrete shall be presented for use up to 50 000 m 3.

Unpolluted or slightly polluted dredging spoils generated in a water management project area shall be placed on the applicant's owner of the water-licensed sea disposal area in accordance with the conditionslaid down in the permit. Contaminated dredging that is unfit forsea drainage is transported to land and placed in the applicant's ownership of land holding permits under the Environmental Protection Act. Such ponds currently exist, for example, in the form of 'Flalasatapaste' and 'Hernesaaari'.

No information was available on the consumption of theproject's soil and structural materials.

The resource efficiency dictators set out in the table belowcan be used for future speculation, as detailed in Chapter 3.2.4.

Indicator	Objective
Totalconsumption of building materials in relation to output (t/m^2) + material needed for maintenance and renewal (t/m^2) divided by the lifetime of the structure	The efficiency of material use is commonly used as tn/m^3 or tn/m^2. When material efficiency is-checked throughout the life cycle of a structure, the totalamount of materials should be distributed over the lifetime of the structure. The meansused are to carry out the project with the maximum-amount of material and to achieve the desired level of service.
Share of recycled materials intotal material consumption (%)	Replacing virgin natural resources by recycling-materials so that the total heat of thematerials does not increase.
Total number of defects to be introduced into the area temperate tooutput (m^{3}rtr and t/m^2)	Carry out the project with a minimum amount of soil and aggregates.
CO2 emissions from the transport of land and stones introducedinrelationto output (t CO2/m²)	The project will be carried out with a minimum amount of soil and aggregates and with minor-passages.
Total volume of land and aggregates to be transported and imported inrelation to output (m^{3}rtr and t/m^2)	Select the ground construction method in such a way asto minimise the quantities of low quality surpluses released during constructionand correspondingly good-quality friction soils — e.g. avoidance of bottom construction through mass swaps. The surpluslands formed by their hands so that they can be exploited on the site. Processing may take the form of e.g. flap, screening, mass stabilisation, etc.
CO2 emissions relative to output from the transport of land and-aggregates to betransportedout of the area	Avoid the need to transport soil and aggregates.
Percentage of imports of virgin earth and aggregates	Reduce the use of virgin earth and aggregates and replace them in suitable parts with secondary and recycled materials. Exploitsurplus soils and aggregates from nearby construction sites.
Percentage of land andaggregates transported out of land and aggregates diverted for recovery (%)	Divert construction surpluses of rotand aggregates for recovery (e.g. for another construction project).

Percentage of total land and aggregatesthat can be rocked and exploited on the plot (%)	Exploit land-based excavations for construction (e.g. fillings). If necessary, provision is made in advance for the clearance ofexcavation sites.

2.2 . Maintenance of ecosystem performance

The main water works involved in the project are the dredging, filling and embankment of the land bench of Palosaaari and the High Island, which lasts more than half a year. Water workscause temporary turbidity of water and spread of nutrients andpotential harm in sediment. Dredging work may in some cases reduce the oxygen contentof water when organic matter in the aqueous phase starts to be decomposition. Dredgings involve nutrients in the sediment that can cause eutrophication. Filling works typically cause turbidity when deposited material in contact with the bottom removes sediment. As fillings are carried out in the lunch, dredgings are the main and most significant impacts on water bodies in this water management project. The strongest catchment area is bounded bythe distance between the dredging area and between the High Island, Mustikkamaa and the Emportand Name Creations.

Dredging works are not estimated to cause oxygen problems on the bottom-loop water layer due to the current good oxygen situation and the mixing of currents. On the other hand, theturbidity of water prevents light propagation in water, which has a detrimental effect on the growth of connecting algae. The risk assessment of water dredgers (Sito Oy and Crede Consulting Oy, 2015) includes anassessment of the effects of harmful substances on ecology and human health. The harmful substances were not considered to pose ecological or health risks in the vicinity of the construction site. Uncertainties related to studies andris kid evaluation were considered acceptable and the risk assessment is reliable.

The project will have an impact on the fishing path between Sompa Island and the High Island. Among the mechanisms affecting fishing, the most significant were underwater noise and thetemporary loss of fishing grounds. The effects on fish stocks and fisheries are mainly caused by the construction of watercourses and are therefore temporary.

Aquatic vegetation and benthic animals are destroyed from dredging and filling areas. However, benthic invertebrates in dredging areas are restored in a few years and water vegetation is alsoestimated to gradually recover, depending on bottom conditions and new depth ratios. In general, the area’s aquatic vegetation is present only in shallow water, as the turbidity vesi prevents the flow of light to deeper water layers. The construction of new bridge pillars/patlons may also have positive effects on the aquatic species as a result of the so-called reefek. The foundations of the power plants create the conditions for increasingthe complexity of aquatic biota by acting as artificial reefs and thus creating new lifestyle for animal and plant species.

The effects of Terrestris during construction are estimated to be mainly on the bird population. The adverse effects during construction are related to the intensity and suddenness of the noise that is different from the rest of the background noise. As a result of explosion or pile noise, the nearbyarea becomes of poorer quality and it can be estimated that the birds will avoid the site at several hundred metres.

Nature reserves in the vicinity of the water managementproject are not affected by any effect that would alter their characteristics or weaken theirfertility. There are no impacts on vegetation and habitats in surrounding areas. The effects during use in the terrestrial ecosystem are estimated to be mainly affectingthe bird population. The bridge’s effects on the bird population during its use are mainly a random risk of collision on bridge structures. Bridge structures would be located close to thebullets, dams and Nimismie in the Kruunu Mountains. Tramway traffic and the noise it causes may, to some extent, weaken the suitability of the bullets in the light of the current stateof the art.

It should be noted that, if the construction works in the Kruunu Mountain are carriedout simultaneously with the hydraulic works of that project, they may increase the turbidity of the sea basin and slightly extend the catchment area in comparison with the area of the effects of thewatercourses during the construction of the water management project. Thearea of the strongest effects would then extend to the Kruunu Mountain.

In order to maintain the functionality of the ecosystems in the project area, presentations have been made for the following monitoring and monitoring:

- Proposal for a Water Monitoring Programme Kruunusillat, Nihti-Kruunu Mountain
- Fisheries monitoring programme for the management of the water management project in Nihti-Kruunu
- Breeding bird surveillance programme using maternal and naming lines
- Follow-up proposals: Noise, vibration and frame sound

3. SOCIO-CULTURAL SUSTAINABILITY

3.1 Making use of local experience and knowledge

The design of runways has mapped local experience withthe system of participation and interaction in the context of planning, EIA and bridge planning. Participants have had access to information about the project, including through public events, bridges, websites and the media. Local experience has been used, for example, inthe design solutions for the zoo site site. In addition, as the projectwas designed, the need to further investigate the impact of the Kruunus Hillages on navigation, boating,marinas and their operating conditions was identified. To this end, a field survey was prepared for the boatand boat movement of the Kruunus pills, challenging stakeholders and recording their needs with regard to boat traffic. The aim of the study is to serve the further design of the Kruunusillat project as a whole. The issues raised by the participants regarding the availability of the bridge (e.g. wind and lightingconditions) have been explored in general planning and the solutions already envisaged will be further refined in the further planning of theland.

The Kruunusillat project employs about 520 man/years per year during construction, and during use, the labour demand is 60 man/years higher than withouttramways. It should be noted that the building works dependent on the Kruunusillat project employ about 600 man-years, including 360 man-years for the-Vartiosaare building. The construction has the potential to employ Finns.

3.2 Developing urban images and safeguarding cultural heritage

With the implementation of the Kruunusillat project, the landscape and the urban landscape will change, particularly in the area of the Kruunu Mountain, where the impact is felt over a large area due to the open landscape and the large scale of bridge structures. During the design of the project, avisual analysis and a wealth of illustrative material have been developed to study the relationship between the bridge and the landscape and urban image. The museum authorities (the City Museum and the MuseumOffice) have had an influence on the design of the project and their views on theset have been taken into account as far as possible. The design solutions have been designed to ensure that the preservation of the values of the World Heritage Site of Finland is not jeopardised and that there are no significant disadvantages for the nationally valuable built cultural environment of the Horse ren/Palosaare. The solutions have been designed to develop maritime Helsinki and open upnew perspectives to view and experience the city. The underwater historical sites in and around the project area have been studied and taken into account in the planning.