Densification as an Objective Towards Sustainable Planning in Reykjavik

Case Study: A Redevelopment Plan for the Ellidaarvogur Area

Katrin Halldorsdottir

Faculty of Civil and Environmental Engineering
University of Iceland
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Katrin Halldorsdottir

30 ECTS thesis submitted in partial fulfillment of a
Magister Scientiarum degree in Environmental Engineering

Advisors
Dr. Trausti Valsson, Professor
Bjorn Axelsson, MA Landsc. Arch

Faculty Representative
Bjorn Gudbrandsson, MArch

Faculty of Civil and Environmental Engineering
School of Engineering and Natural Sciences
University of Iceland
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Faculty of Civil and Environmental Engineering
School of Engineering and Natural Sciences
University of Iceland
Hjardarhagi 2-4
107, Reykjavik
Iceland

Telephone: (354) 525 4000

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Abstract

The world's cities, towns, and neighborhoods need to be planned and redeveloped in a way that makes them better places to live in. Healthy, attractive and economically successful places are needed, and at the same time a dramatic reduction of greenhouse gas emissions is required. Planners can play a crucial role in this endeavor because low carbon and sustainable lifestyles can be worked towards and supported through proper design of living spaces. The layout and quality of the urban environment, for example, affects people's choice of travel mode.

Reykjavik is a city of low density and high automobile ownership. Around the year 2000 it was decided politically to develop Reykjavik and the Capital Area with higher density and to try to make the area less car dependent. It is argued that with higher density a city becomes less car dependent and friendlier for pedestrian use and biking.

Reykjavik's draft for a General Plan that extends to 2030, identifies the ERB Area as one of the key areas for redevelopment in the near future in order to make the city denser. This thesis focuses on finding a sustainable way to plan and redevelop the ERB Area to accomplish this greater density.

Útdráttur

Borgir, bæjir og hverfi þurfa að þróast í átt að betri stöðum til að búa í. Það er þörf á heilsusamlegum, aðlaðandi og efnahagslega árangursríkum stöðum sem stuðla að lágmarks losun gróðurhúsa lofttegunda. Skipuleggjendur gegna grundvallarhlutverki við þetta verkefni. Með ákveðinni tegund af hönnun á stöðum í borgum er hægt að stuðla að sjálfbærum lífstíl sem hefur lága kolefnalosun. Til dæmis hafa gæði og uppbygging hins byggða umhverfis áhrif á val fólks á ferðamáta.

Reykjavík er borg af lágum þéttleika og með mikilli bílaeign. Frá því í kringum árið 2000 hafa yfirvöld verið með þá stefnu að þróa Reykjavík og nágrenni í átt að meiri þéttleika með það að markmiði að minnka bílanotkun. Því er haldið fram að meiri þéttleiki stuðli að minni bílanotkun, og um leið meiri notkun á almenningssamgöngukerfi og að hún auðveldi umferð gangandi og hjólandi.

Núverandi drög að Aðalskipulagi Reykjavíkurborgar tilgreina Elliðaárvoginn sem eitt af lykilsvæðum til að þétta borgina í náinni framtíð. Þetta MS-verkefni miðar að því að finna sjálfbæra leið til að skipuleggja og endurþróa Elliðaárvoginn með það að markmiði að þétta byggð borgarinnar.

This thesis is dedicated to the memory of my grandmother Kristín María Gísladóttir.

Preface

This thesis is the final project toward a Master's degree in environmental engineering at the University of Iceland. Before this thesis was written the author stayed as an exchange student from July 2010 till May 2011 at Kungliga Tekniska Högskolan, KTH, in Stockholm, Sweden. The author completed 60 ECTS credits in the study program Sustainable Planning and Design - Urban and Regional Planning at KTH. The author was highly inspired by Stockholm, as the city is considered outstanding regarding urban sustainability and was the chosen Green Capital of Europe in 2010, the same year the author moved to the city.

The idea for this thesis started developing during my stay in Stockholm, after participating in a group project assigned in the course Sustainable Planning and Design at KTH. The project's name is Sustainable Densification in Huvudsta, and is partly used in this thesis.

Another group project, assigned in the course Town and Country Planning at the University of Iceland, is also partly used in this thesis. The project's name is Center of Sustainable living. The task was to create a plan proposal for the same case study as in this thesis. The project is shown in Appendix B.

Table of Contents

List of Figures

List of Tables

Glossary

CABE: An organization providing sustainability advices about how to design places. The aim is to help decision-makers and professionals to create great buildings, places and spaces, and inspire public demand for good design (Commission for Architecture and the Built Environment, 2011).

Detail Plan: A plan made for neighborhoods or any other sections within the frame of the general plan. It accounts for the area's use of land, the road system, types of residences, occupations and services, housing, institutions, playgrounds, recreational areas, etc. (Valsson, 2003).

General Plan: A plan level beneath a regional plan. Such a plan is made for every community sometimes for more than one community at a time. The purpose of the plan is to show the main policy of a community in a physical plan, e.g., in terms of how the settlements should develop, what land uses there should be, as well as the placement of the main traffic lines. This plan gives a frame for the detail plans (Valsson, 2003).

Infrastructure: Internal structure in a country, region or town. There is social, economic, and technological infrastructure. The road system is most often identified as the most important infrastructure in planning (Valsson, 2003).

Land-use: The main categories of land-use are areas for residences, industry, shopping, warehousing and outdoor life (Valsson, 2003).

Mixed land-use: If an area is a mixture of different functions or building types, it is called mixed land-use. Social mixing (integrating) is often used to reduce social problems (Valsson, 2003).

New Localism: A concept that emphasizes a need to solve local activities on a local scale opposed to a national or global scale. Local solutions strive for using local resources and lead them into local recycling processes. This can apply for a range of things, such as food production, work, shopping, energy, etc. This concept helps reducing dependency of resources from elsewhere and reduces transport and travel distances, and thus makes communities more self-reliant and sustainable.

Peak oil: A point in time where the maximum rate of petroleum extraction has been reached in the world. Depletion refers to the falling of oil reserves and supply after peak oil has been reached.

Planning process: How work on a plan proceeds. It includes preparatory work, development of aspects, collecting and analyzing of data, creating of alternatives, policy making, and co-operation with the government in question as well as with the public. The final steps are: decision making, advertising, environmental impact assessment, governing of the plan and review (Valsson, 2003).

Regional plan: A plan that covers at least two communities with the goal of creating a coordinated policy on the development of settlement and infrastructure in a region, and to support economic development. The regional plan is the frame for the general plan level (Valsson, 2003).

Resilient: Something is resilient if it responds to a trial without much damage or irreversible effects; it means to be flexible and adaptable and also sturdy. Newman, Beatley, & Heather (2009) identifies the resilient city to be: A city that can respond to a natural disaster, resource shortage, and a city that recognizes human impacts on climate change and other problems.

Sprawl: The opposite to dense urban development. Often defined by the spreading of urban settlement patterns over a large area, resulting in low urban density. If the sprawl happens according to the zoning principle, this implies that residential and commercial units are growing separated from each other. In urban sprawl and low density, housing often takes the form of single family houses. The resulting major transportation is most often the privately owned automobile.

Sustainable development: A principle that proclaims that the use of resources should not damage or reduce their capacity. Only in this way can their utilization become sustainable. This principle not only covers the natural environment but it also pints out the need for the same type of thought in conceiving and analyzing social and economic environments because all for these three elements are interdependent (Valsson, 2003).

The ERB Area: The Icelandic name of the Case Study in this thesis is *Elliðaárvogur*. *Elliða* is a place name, *ár* means river and *vogur* means bay. The exact translation to English would therefore be Ellida River Bay. The name is a tongue twister, and therefore it was decided to call the case study area the ERB Area in this thesis.

The Ellida River: Is the river that runs through the Case Study area, in Icelandic it is *Elliðaá*. *Elliða* is a place name and *á* means river. The Engilsh translation would therefore be Ellida River.

The Ellida River Valley: Is the Valley south of the Case Study area, in Icelandic it is *Elliðaárdalur*. *Elliða* is a place name, *á* means river, and *dalur* means valley. The English translation would therefore be the Ellida River Valley.

Zoning: The division of functions in an urban area into detached spaces so that they do not disturb each other. Example: the separation of polluting industries from residential areas (Valsson, 2003).

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I would like to thank my advisors for their time, help and advice on writing the thesis: Trausti Valsson, Professor of Planning at the University of Iceland, and Bjorn Axelsson, Head of the Environmental Department in Reykjavik's Planning Office.

I would also like to thank my family for their ongoing support throughout my studies. Special thanks to my dad, Halldor Eiriksson, who has helped a lot in solving technical issues.

1 Introduction

"By 2040, the Sahara will be moving into Europe, and Berlin will be as hot as Baghdad. Atlanta will end up a kudzu jungle. Phoenix will become uninhabitable, as will parts of Beijing (desert), Miami (rising seas) and London (floods). Food shortages will drive millions of people north, raising political tensions. The Chinese have nowhere to go but up into Siberia. With hardship and mass migrations will come epidemics, which are likely to kill millions" (Newman et al., 2009, p.37)

Those are the words of James Lovelock who believes that by 2020 we will start experiencing extreme weather because of climate change which he sees as irreversible. Two of the most urgent global issues of the 21st century are probably how fast climate change is happening and peak oil use. These two issues are strongly connected; we need to reduce all fossil fuel use to reduce human impact on climate change. We also need to make big changes in order to make our cities resilient to climate changes and peak oil use. The changes can be reached through long term planning towards sustainability and also by taking steps towards short-term adaptations, which will eventually lead to fundamental changes in how to live and plan cities. We need to see changes in the planning of cities that contribute to reduction of the carbon footprint, minimized dependence on fossil fuels and minimized impacts on natural resources. A way to make these changes is by adapting cities to a lessened need for fossil energy (Newman et al., 2009).

The task at hand is hard to tackle, since fossil energy use has grown in almost every city in recent decades. The twin dilemmas of peak oil use and climate change are being recognized by global governments and requirements have been made to make cities use less fossil fuel. Taking action in cities to reduce the impact on climate change is becoming a political and legal necessity. Technical solutions alone will not be enough; there is a need for change in our lifestyles, cultures, and economies (Newman et al., 2009).

That the focus is set on cities, when responding to climate changes and peak oil use, is not without reason. Over the past decades we have been experiencing increased urbanization in the world, and cities are growing by 2% on average every year. Today, half of humanity lives in cities, and it is estimated that by 2030 60% of the world's population will live in urbanized areas. Cities are responsible for 80% of the world's greenhouse gases, which can at the same time be looked on as an opportunity for reduction in emissions. It is ideal to start the needed change on a city level because of the cities' high share of greenhouse gas emissions in general (Newman et al., 2009). The city planner can play a crucial role in fighting global warming by developing the city to make the changes become a reality.

Iceland is no exception in experiencing climate change, facing great transformation with melting glaciers and dramatic changes in weather patterns. The focus of this thesis is set on how Reykjavik should be developed to respond to climate change and peak oil use, and to respond to the most urgent local sustainability issues. The aim is to explore whether today's unsustainable lifestyles in cities can be changed through urban planning, and if so, how it should be done. The methods used in this thesis are a review of literature and theoretical research, followed by creation and analysis of a case planning project.

The focal issue of the revised version of Reykjavik's General Plan is sustainable development, with the goal of making the city denser. One of the identified key areas for densifying the city is the Ellida Bay Area (Icelandic, Elliðaárvogur). This thesis is divided into two chapters. The first, Chapter A, is based on theories and research on how urban areas can be planned and developed in a sustainable way, with special attention to sustainable densification. The second, Chapter B, is the practical chapter consisting of a case study wherein a plan proposal is made for the Ellida River Bay Area, called the ERB Area in this thesis. The sustainable planning principles identified in Chapter A are used when formulating the plan proposal.

2 Part A: Theoretical Background for Sustainable Planning

Places need to be healthy, attractive and economically successful, in general, a better place to live in. The decisions people take matter to achieve the realization of this vision of a place. It is argued that sustainable places help people take the right decisions in making places better for living and to reduce greenhouse gas emissions. Different actions suit different places; there is no one solution that fits all cities and towns (Commission for Architecture and the Built Environment, 2011).

This chapter explores, theoretically, how to plan or redevelop urban areas in a sustainable way, how to plan cities and design places to encourage sustainable living and fulfill environmental, social and economic needs. Through planning and design, we can control the consequences of how things are made, resources are used, land is developed, infrastructure and buildings constructed, services supplied and how places are connected. By planning places using sustainable planning principles, the aim is to figure out ways to adapt to the impact of climate change and help mitigate greenhouse gas emissions.

The relationship between urban areas and sustainability is investigated, and which planning principles to follow, when planning and redeveloping a city in a sustainable way. To be able to do this, sustainability must be introduced.

2.1 The Concept of Sustainability

What is sustainability? Neuman (2005) thinks that sustainability is both a broad and vague term which can have many meanings. He thinks of sustainability as a Platonic idea, a new idea with no clear definition. It is a category of the good, he says, but has no single clear image yet. Sustainability can also be looked at as a debate about how to live, suggesting rethinking our life pattern, with the aim of reaching a balance among equity, economic, and environmental concerns (Neuman, 2005).

2.1.1 Sustainable Development

The standard definition of sustainable development was coined in the Brundtland Commission report, which defines it as: “development that meets the needs of the present without jeopardizing the ability of future generations to meet their own needs” (Wheeler & Beatley, 2009, p.59). This definition is usually translated into the simultaneous satisfaction of three objectives: economic efficiency, environmental protection, and social justice (Briassoulis, 1999, p. 890). More recently, Hopwood, Mellor, and O'Brien (2005) have described the social justice component as a means to eradicate poverty, meet human needs and ensure that all get a fair share of resources.

2.1.2 Urban Sustainability

There has been much discussion on sustainability in the urban context. Migration trends show that people are moving from rural areas to cities; today four of five Europeans live in

urbanized areas (Pedersen, 2009, p. 18). Maclaren (1996) thinks of sustainability as a desirable state or set of conditions that persists over time, the key characteristics of urban sustainability being: intergenerational equity, protection of the natural environment, minimal use of non-renewable resources, economic vitality and diversity, community self-reliance, individual well-being, and satisfaction of basic human needs (Wheeler & Beatley, 2009).

From another perspective, Carmona (2009) focuses on reducing the lifetime environmental impact of any development life cycle: construction, occupation and demolition, by reducing dependence on the wider environment for resources and reducing pollution of the wider environment by waste products.

According to Marcuse (1998), sustainability is not an appropriate goal when focusing on housing and urban development. As a goal, it suggests that all humanity shares the same interest in sustainable housing or sustainable urban development. Universal acceptance can also be a bad idea because the status quo can be perpetuated sustainably, in the case where one person's benefit can come at the unjust expense of another. This is the case in the environmental sphere, where he rightly states that the status quo cannot be sustained and the only question is how rapidly to ameliorate it. Good planning, he says, calls for social justice as well as environmental sustainability whereby the long-term consequences of a proposal must be addressed.

2.1.3 Sustainability as a Constraint

Marcuse (1998) therefore proposes that sustainability should be a constraint on the achievement of other goals whose absence may limit the usefulness of a good program. According to the Brundtland Commission's definition of sustainable development – "meeting the needs" and "making it sustainable" – it is obviously a constraint on the appropriate means to be used. Sustainability can be a useful formulation of goals on environmental issues. On the other hand, sustainability is a treacherous formulation of goals for urban policy because it suggests the possibility of a conflict-free consensus on policies, and vital interests do usually conflict. Therefore, Marcuse determines that sustainability cannot be the sole criterion by which programs are judged, even in the environmental arena, because environmental policies must also take into account considerations of, for example, social justice. Sustainability as a constraint should let any measure – desirable on other grounds – meet substantive goals and be capable of maintaining and contributing to the desired long term goal. Sustainability as a constraint, he says, can be used as a criterion to evaluate measures that achieve otherwise defined desirable goals.

Marcuse's approach to sustainability was mainly used when formulating the plan proposal in Chapter B, that is, using sustainability as a constraint on the goal of densification, for the goal has already been politically decided. The main task at hand is to densify the city by redeveloping the ERB Area. Those actions should therefore be done under the constraint of sustainability, as Marcuse suggests. The three aspects of sustainability must be considered: environmental, social and economic. No targets or indicators will be used to measure sustainability in this thesis, but the aim is to improve the current environmental situation where possible. The social and economic spheres result in part from local community choices.

2.2 Climate Change

Most scientists state without question that global warming is a fact, and most posit human causes. The need for change in how we live and plan our cities has started to become accepted

all over the world. Examples of the serious consequences of climate change are increased storms, droughts, heat waves, forest fires and sea level rise. Many argue that the increase in many natural disasters of late can be linked to climate change. According to the Intergovernmental Panel on Climate Change (IPCC), greenhouse gas emissions need to be reduced by at least 50% by the year 2050 to avoid a further temperature rise. To meet this reduction goal, cities need to reduce their use of fossil fuels by 25-50%. To reach this goal we need help from technology that saves energy and we also need to rethink the way we plan and operate our cities (Newman et al., 2009).

Global governance of climate change is important, such as the Kyoto protocol, which has clear goals of greenhouse gas reductions. The Kyoto protocol has not only set reduction of emission targets for different countries but has also led to a global awareness of the problem, which is a good start. Climate change and peak oil use are global problems, and in order to be able to deal with them it is important to create constructive policies and in every country (Newman et al., 2009).

The cities of the world are as diverse as they are many, and therefore different actions can suit different cities. To start with, it is important to identify the most urgent local sustainability issues in order to realize how to respond to them. The next two sections are an effort to do so, with a short summary of how Iceland is experiencing climate change, followed by an attempt to identify the most urgent local issues.

2.2.1 Iceland and Climate Change

With increased temperature the Icelandic summers are getting warmer and winters milder, sea levels are rising and glaciers are melting. According to the Intergovernmental Panel on Climate Change (IPCC), sea level rise in the twenty-first century will amount to 40-60 cm. Iceland is subsiding by approximately 30 cm per century and this subsidence together with the expected sea level rise can be a threat to the built environment (Valsson, 2000). According to Tomas Johannesson, the sea level rise along Reykjavik's shores can possibly be up to 6 meters in several hundred years. He says that it is impossible to predict accurately the sea level rise in the future, but if we assume today's development continues, these numbers are what we could be facing (Figure 1) (Guðmundsson, 2011).

Glaciers cover about 11% of Iceland's dry ground today, with the biggest glacier in Europe, the Vatnajokull, covering 8%. Iceland's glaciers, however, are decreasing fast, contributing to more water flow in glacial rivers and, possibly, more frequent or bigger volcanic eruptions in the future (Björnsson, et al., 2008). Some scientists argue that eruptions in Grimsvotn can be related to global warming because with the Vatnajokull decreasing and therefore a reduction in weight on the underlying ground it becomes easier for Grimsvotn, which is placed within it, to erupt. Volcanic eruptions have both global and local impacts. The ash from a volcanic eruption affects the daily life of citizens in Iceland and has caused sickness and even the death of sheep and other animals from the fluoride and particulate matter the ash contains. Ash clouds from volcanoes like Vesuvius have created havoc and death in the past. Today, with the importance of air traffic, disruption of travel even all around Europe and elsewhere, can result from the outpouring of volcanic ash from volcanoes in Iceland.

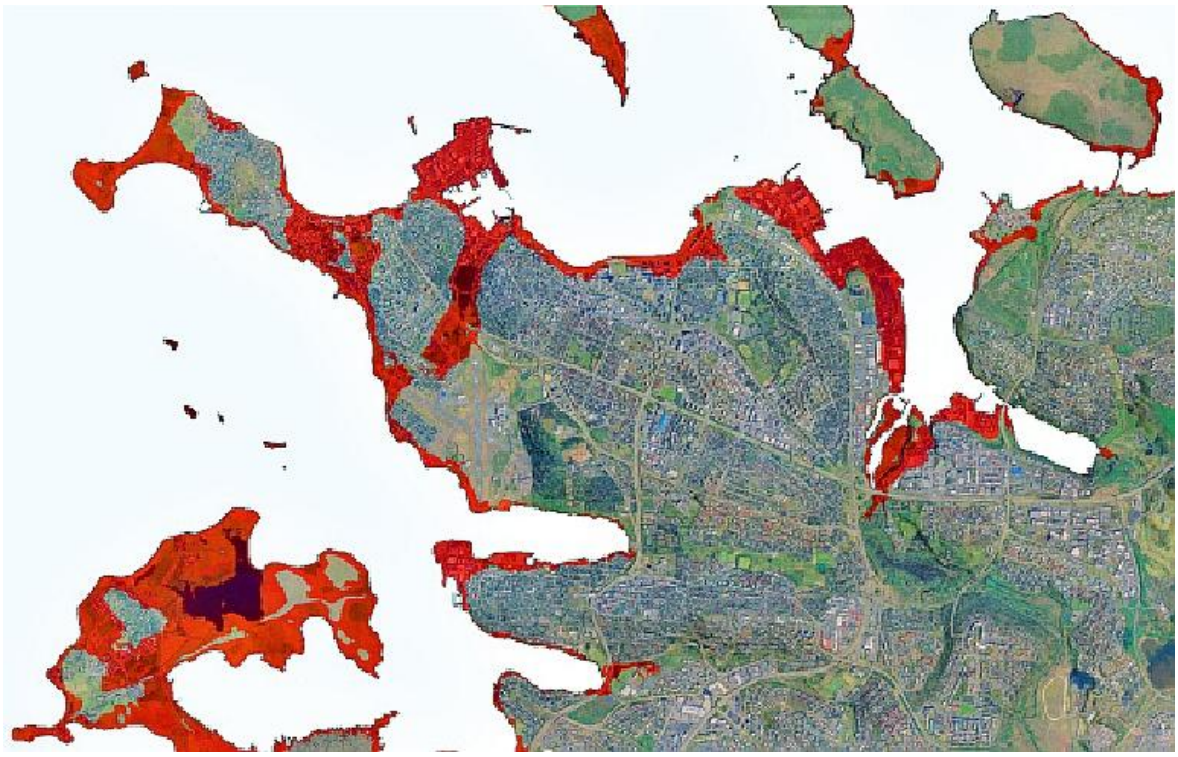

Figure 1: The possible 6 meter sea level rise in Reykjavik, shown in red (LOFTMYNDIR EHF, 2011)

It is argued that global warming also has positive aspects for Iceland. The Icelandic situation is quite unique when it comes to global warming; for example, sea ice has been one of the country's worst enemies because the nation has had to rely on fishing and ocean transport to remain, through the centuries, in contact with the rest of the world and to support its economy (Valsson, 2006). Valsson (2006) criticizes climate change impact discourse because it is all more or less focused on the negative impacts on the environment, missing out the fact that it means less ice, a better climate and more and different vegetation for arctic and subarctic countries such as Iceland. Valsson (2006) says that "The Arctic will experience more extensive warming in the future – probably by 4 to 7°C in the present century – than other areas of the globe. This will result in a rapid reduction of the polar ice and create a more habitable climate that will make the North the premier future development area of the globe" (p. 125).

The summers are becoming warmer in Iceland, which the residents enjoy, and has positive effects on trees, for example. The forests will expand and the trees will probably grow taller (Björnsson, et al., 2008). With the melting glaciers the water flow in the rivers becomes stronger, having positive effects on the hydroelectric industry. The renewable energy sector is enlarging in Iceland, with experts exploring and developing renewable energy use. Electricity used in Iceland comes mainly from renewable sources and servicing 90% of the buildings. Iceland is hoping to become the first country not dependent on fossil fuel (Cox & Bragadottir, 2008), using renewable energy instead, with the aim of running the entire transport system on hydrogen power by the year 2050.

Global warming has both positive and negative effects in Iceland, but looking at the whole picture it is a threat to humankind in general. This is why every country needs to participate

in action to slow down the human impact of global warming by, for example, setting and complying with reduction targets of greenhouse gas emissions. As pointed out, planners can play a crucial role in this development. To start with, planners need to realize which the most urgent local issues are, which actions are needed and which changes are necessary.

2.2.2 Local Sustainability Issues

Oil accounts for around one third of greenhouse gas emissions in the world. Environmental impact will decrease with reduction in oil use. Even though renewable fuel is available technically for cars, fossil fuel use is increasing, making the transport sector the most worrying part of the greenhouse gas emissions profile in many areas of the world (Newman et al., 2009).

Iceland is one of those areas in which the industrial and transportation sectors account for the highest greenhouse gas emissions. Iceland's emission profile differs from that of other countries because of how low the building sector emissions are, because of the renewable energy used for heating the buildings (Höfundar, 2010). The country's car ownership, on the other hand, is shocking. According to *The Economist*, Iceland had the second largest car ownership in the world in the year 2009, or more than 600 cars per 1000 inhabitants (The Economist Newspaper Limited, 2011).

Reykjavik, the capital city of Iceland, can be called an ideal car city. The former development of the city has contributed to the high car ownership; with urban structure not properly providing for any other travel possibility than the automobile. The public transport system in the city consists of a bus system. Early in 2011 the bus company cut down their services, making it almost impossible for residents to depend only on public transport to travel. The ambitious goal of running the country's entire transport on renewable energy in the year 2050 is great, but 39 years is too a long time to wait – changes need to be made now. With the entire transport system running on renewable energy the greenhouse gas emissions will decrease but will not solve other problems regarding the private car, such as health and safety problems. The growing use of privately owned motor vehicles is impacting air quality and therefore human health.

According to Valsson (2000), today the term sustainable development is worldwide and has started to be implemented in many fields. For example, sustainable development has been implemented in the fishing industry in Iceland, with great results in saving fishing stocks. However, the term has not been properly used or implemented as yet in the planning field in Iceland.

The planners of Reykjavik should aim for developing the city in a way that reduces car dependency because that is one of the most worrying sectors of the country's greenhouse gas emission profile. This can be done by focusing on densification, which is argued to be a good way to make urban areas less car dependent. Minimizing car dependency will also result in reduced health problems such as obesity, stress and depression (Newman et al., 2009). This fact should give the planners in Iceland even more reason for doing this, because according to a recent OECD health report, the Icelandic nation is one of the fattest nations in the world. Six of every ten residents are overweight and two of every ten struggle with obesity. What is interesting is that Iceland differs from the other Nordic Countries, which are all under average regarding obesity (Eyjan Media ehf., 2010). The Nordic countries are also ranked much lower than Iceland in the list of car ownership, with Finland ranked in 17th place, Sweden in

18th place, Norway in 22nd place, and Denmark in 32nd place (The Economist Newspaper Limited, 2011).

The reason why Reykjavik is so dependent on cars is probably because it developed to be a wealthy country with few residents. Valsson (2000) writes that because of how many beautiful places the country has, the people did not respect and appreciate them properly when urban areas were formulating. This is one of the reasons why Reykjavik is so wide spread, with the city having many big undeveloped areas in between built areas. The reason for the unsustainable development of Reykjavík can also partly be related to the economic boom which reached its high point in 2005-2007, making it really popular for citizens to buy their own land to build on in the outskirts of the city. The economic crisis in 2008 left those rising suburbs unfinished, unfeasible and unpopular to live in. It can be said that the economic crisis is a milestone in Reykjavík's development, making the planners rethink the development, look back and realize what can be done better.

Today awareness of the unhealthy development of Reykjavik is increasing. The government of Iceland announced in April 2011 that 1 billion Icelandic kronas, or about 6,050,700 euros, will be spent every year for the next 10 years to strengthen the public transport system in Reykjavík (mbl.is/Árvakur hf., 2011). In 2003 a campaign started in Reykjavík called "ride your bikes to work", and has successfully been continued every year since. The aim is to get citizens to choose to use bicycles instead of cars (Hjólað í vinnuna).

In the late 17th century Reykjavik was a small town, which was planned with urban farming at every house, which was a new thing in those days. Around 1900 the number of inhabitants had increased and the vegetable gardens and fishing were crucial in helping people to afford to live. In the economic crisis which began in 1930, small plots were offered within the city for urban farming. This helped a lot of people who, for example, had no work (Valsson, 2000).

In May 2011 urban farming was introduced again in Reykjavik where residents have the option of renting a space to grow their own food in five neighborhoods in the city (mbl.is/Árvakur hf., 2011). Because of how cheap the cost of energy is in Iceland compared to other countries, there are plenty of opportunities for urban farming. A revolution could be carried out in this field, which would contribute to a more sustainable and healthy lifestyle, with local vegetable and fruit production. Vegetables, largely imported, are considered to be expensive in Iceland. With growing vegetables close to homes, urban farming could become a normal household job (Valsson, 2000).

There are many possibilities for a greener lifestyle. Small steps towards this development are being taken, but to see real changes the steps need to be bigger. Some citizens do not agree with this development.

Recently a law student wrote an article published in a popular online news website stating that "the haters of the automobile" are running the city by a development which forces people to use their car less and use "unpopular travel options such as buses and bicycles" instead. The author writes that with this development his freedom is threatened, which he defines as being able to use his car as he pleases (Bragason, 2011). This is a good example of how many residents think and feel about a greener lifestyle. The big challenge is to make the citizens realize how important it is to change their behavior.

The big question is probably if it is possible to change human behavior and people's lifestyle through the design of cities. Newman et al. (2009) identifies the starting step as developing the city in a way that offers a changed lifestyle, with the transportation sector as the most crucial one for prompt action. A higher density creates shorter commuting distances which can easily be covered on foot or by bicycle and the public transportation system thereby becomes more efficient.

Iceland is characterized by a large uninhabited area coupled with a rural environment with a very small population, in other words, a great deal of open space. This has resulted from our history of farms, earlier deaths from starvation, and the historical inaccessibility of the highlands for other than summer grazing. Low density is therefore part of our culture; it cannot be traced to escaping the unhealthy environment in the overcrowded industrial cities of Europe, for instance, in the 18th century. The few urban areas that have grown up largely from earlier trading areas remain surrounded by open landscapes. Even Reykjavik, as a center of banking, education and business, has never been an overcrowded city. The Icelandic residential form is characterized by wanting to have a good view, with a lot of private space. There has been very little interest in living close to one's neighbors, in comfortable closed areas around a square. This is a changing fact, as the young generation of today has shown interest in that kind of society, even though it means little in the way of a view and small gardens (Valsson, 2000). This newer interest, coupled with the need is to take action in order to solve local sustainability issues, provides a reason is given to develop Reykjavik in such a way as to make the necessary changes happen, which can be done with making the city denser.

2.3 Densification

To make our cities less vulnerable to climate change the focus should be on the transportation sector in many countries, including Iceland. To ease our addiction to oil and respond to health problems, it seems logical to focus on making cities denser. By overcoming car dependence we will not only lessen city emissions, we will also gain environmentally, economically, health-wise and socially (Newman et al., 2009).

How to make our cities denser does matter. Before investigating how to develop cities with higher density in a sustainable way, it is important to introduce what density is.

2.3.1 The Concept of Density

There are many ways of explaining urban density and compactness. In this thesis the aim is to grasp the general idea more than finding a clear definition. The most effective way to explain it is probably to give examples of how the term is being used and describing the general idea of what density and compactness imply in terms of urban forms and their functions, both in discourse and in practice.

In considering the discourse of urban development today, there seems to be a homogeneous idea where densification is one of the main measures creating sustainable cities. The consensus sometimes seems so dominant that it appears unlikely that anyone opposes the idea of promoting the compact city as a way of approaching more sustainable cities. However, this has not always been the case. At the end of the nineteenth century, density was looked upon with very different eyes. The high densities of industrial cities were often seen as the main

cause of fires, disease and social disorder (Berghauser Pont & Haupt, 2010). Almost a hundred years ago, Sir Raymond Unwin (1919) believed that there was nothing good at all with overcrowding inner cities and proposed a standard of a maximum of thirty houses per hectare. Fifty years later, Jane Jacobs (1961) argued strongly that at least 250 dwellings per hectare were needed to make social and economic vitality possible. Even concrete and quantitative descriptions like these can be meaningless and vague, since most of us probably do not think of urban environments in terms of dwellings per hectare but rather in terms of pictures, urban spaces, facades, movement and action. In order to get an idea of the concept, actual examples are needed.

2.3.2 Urban Sprawl

Density and densification are often pictured as both the opposite and the solution to the rapid decentralization of cities commonly called as urban sprawl. To understand compactness or density, sprawl needs to be explained. In short, sprawl is defined by widespread patterns of large area and low density urban growth. It implies residential and commercial units growing separated from each other. Housing often takes the form of single family houses. The major transportation is the privately owned automobile. The automobile is also often said to be what once started and made this development possible, since it made people less dependent on proximity to the central city with services and working places (Farr, 2008, p.298). Apart from mobility provided by car ownership, other driving forces are economic priorities such as cheap open land outside the city and cultural traits including the post-war individualistic lifestyle, in other words a demand for larger living space (Newman & Kenworthy, 1999). Sprawl is often exemplified by the North American suburban expansion which is characterized by disconnected, single-use developments; cities where the core is abandoned, and commerce and services are redistributed to external malls and office parks along highways, often hardly reached without a car (Farr, 2008). Studies show that working families that live in suburban sprawl areas in the United States and Australia spent between 20-40% of their income on transport, almost all for private car travel (Newman et al., 2009). Burchell (1998) defines what characterizes the North American sprawl suburbs, consisting of the ten elements listed in Table 1 (Neuman, 2005).

Table 1: Ten elements that define sprawl as a form of urban development defined by Burchell (1988) (Neuman, 2005, p.15).

Urban sprawl characteristics

1. Low residential density;
2. Unlimited outward extension of new development;
3. Spatial segregation of different types of land uses through zoning;
4. Leapfrog development;
5. No centralized ownership of land or planning of land development;
6. All transportation dominated by privately owned motor vehicles;
7. Fragmentation of governance authority of land uses among many local governments;
8. Great variances in the fiscal capacity of local governments;
9. Widespread commercial strip development along major roadways;
10. Major reliance on a filtering process to provide housing for low-income households.

2.3.3 Urban Density

If the description above is what characterizes the sparse and sprawling city, what then does actual density look like as an urban form? Thomas and Cousins (1996) illustrate their idea of urban density by phrasing: "Initial impressions evoke an intense medieval city, whose limits are clearly visible, and where the hubbub of daily activity is confined within the city's walls. It is a product of a certain form, scale and mix of activities." (Jenks, Burton, & Williams, 2002) Although many European cities have also experienced considerable decentralization, historical western European cities such as Amsterdam and Paris are typically used to illustrate what a dense city is like (Wheeler & Beatley, 2009). Still, many authors in favor of the compact structure do not describe their vision explicitly (e.g. with models and references), but rather by using common features. As Burton (2000) puts it, there are a variety of definitions of the so-called compact city, but generally it means a mixed use city of relatively high density, a form that makes an efficient public transport system possible and encourages people to travel on foot or by bicycle.

Newman et al. (2009) argue that by developing cities with high-density the gain will be in lower greenhouse gas emissions from transport and if nothing is done, automobile usage will increase with the increase in population, CO_2 emissions will grow and average world temperature will increase. Newman et al. (2009) state that: "The denser a city the less its residents drive, the more they use transit, walk, and bike. This suggests that people drive mostly because they have no other alternative. Providing density to support transit, walking and biking is a critical component in reducing greenhouse gas emissions. In the United States, according to a 2007 study, 'shifting 60 percent of new growth to compact patterns would save 85 million metric tons of CO_2 annually by 2030'" (p. 84).

When studying the concept of urban density, a number of features are used time after time. The most frequently observed are:

- Less car dependency;
- Efficient public transport;
- Walkability;
- Increased accessibility;
- Mixed land use (mixed functions);
- Energy efficiency;
- Social interaction.

2.3.4 Measuring Density

When it comes to actual measurements of density, a number of combinations of either inhabitants or buildings are placed in ratio to the area of land. Density is the average number of people, families, or housing units on one unit of land, also expressed as dwelling units per acre (Farr, 2008, p.298). The area that the density is based upon must also be taken into consideration, as the following example illustrates: The population density of the municipality of Amsterdam was 44 inhabitants per hectare in 2000 (excluding water). The density of its urbanized areas, however, was 63 inhabitants per hectare, and the gross residential density – excluding large-scale working areas and green areas – was almost three times higher: 125 inhabitants per hectare. (Berghauser Pont & Haupt, 2010, p.13)

Density can be used in a number of ways, showing various aspects depending on the context. The number of persons per hectare could be useful for a detailed plan, while immigration rates and patterns of mixed use are of more interest when analyzing a larger area. Furthermore, a set of quantifiable measures of density could become a limitation to planning if used out of context. The concept of density seems to have turned from being an expression of built environment/inhabitants per area into a "multivariable phenomenon" (Berghauser Pont & Haupt, 2010, p. 261)

2.3.5 Critiques of Density

As mentioned initially, there seems to be quite a strong consensus claiming that density and densification should be the catchwords when planning urban development, but of course there are those opposing this idea. Some mean that there is an overly romanticized illusion of creating a traditional, vibrant city, when the reality shows results such as congestion and worsened air quality. In other words, densification brings overcrowding and congestion back - problems people once fled from (Jenks, Burton, & Williams, 2002). Some "decentralists" are skeptical of the actual environmental benefits from densifying, meaning that the reduction in, for example, energy consumption and emissions will be equivalently small compared to the assumed discomfort of making people live denser, drive slower/less, etc. (Jenks, Burton, & Williams, 2002). Another argument is that the trend of decentralization is too strong. Accordingly, people want a good deal of space and their own gardens, and the economic benefits from reintroducing mixed use density is questioned (Gordon & Richardsson, 1997). What also speak against densification are the high energy and renovation costs that come with brownfield developments, and the reuse of existing infrastructure (Jenks, Burton, & Williams, 2002).

Neuman (2005) questions the relationship between urban density and sustainability. He refers to studies resulting in limited or not conducive relations between social equity and compactness. Car trips used for short distances to local activities may decrease with a more compact urban form, but for those seeking specialized employment, unique shopping, or singular leisure, urban density does not matter. Weekend air travel, business travel, and an increase in dispersed life patterns in general are why urban design alone cannot reduce the travel demands of energy-rich transport modes. Neuman (2005) puts a question mark to studies showing a relationship between trip frequency and density, because only some studies show that there is a relationship. Other factors must be included, he says, such as fuel prices and income. Health and well-being are important sustainability factors, which must be considered in the compact urban form. Stress and other psychological condition are sometimes said to be caused of high density. The hypothesis that compact mixed use urban form enables people to use bicycles and walk more, which leads to less health issues because

people are more fit, is also questioned in Neuman's article, because factors such as diet, genetics, quality and access to health care and so on need to be investigated as well.

Even though compact structure and urban areas with high density are considered the opposite of urban sprawl, which is considered an urban form with many sustainability problems, it cannot be looked at alone as a key act, by itself, towards sustainability.

It is argued in this thesis though, after exploring Icelandic situations, that the most important step towards sustainable development in Reykjavik is to develop the city with higher density. The danger of the city becoming overcrowded or really compact is almost zero because of how few residents there are. Fuel prices in Iceland are considered to be high, so cheap fuel is not the reason why the residents drive so much. Access to a good health care system is not considered to be lacking, and therefore this is not the reason for the health problems of residents. These facts therefore do not support some of Neuman's (2005) main arguments against developing the city with higher density.

With developing Reykjavik with higher density, the aim is simply to give people the option of relying on travel alternatives other than the car. The option of using the car will still be available, and will probably still be popular, with the country having great potential in developing renewable energy technology for fueling motor vehicles.

Density as a concept, rather than an exact measurement is of the most interest in this thesis. But how to develop the city with higher density matters, and other important sustainability considerations in the field of planning will be explored in the next section.

2.4 Effects of Densification and Sustainable Planning Advice

The revised version of Reykjavik's General Plan has the goal of making the city denser. Where to make the city denser, and how to accomplish this, is crucial for the development to be considered sustainable. According to Berghauser Pont and Haupt (2010), dense cities are a precondition to sustainability, and therefore space should be treated as a scarce resource. Urban infill development and retrofitting buildings is a way of making cities denser, accommodating growth while saving green areas on the urban fringe from sprawl.

The ERB Area is identified as one of the key areas for densifying Reykjavik. The area is the Case Study of this thesis. An organization called CABE gives good advice about sustainable planning. The organization has the aim of helping decision-making in creating great buildings, places and spaces. By "great" is meant that buildings should be functional, sustainable, and delight people. It is an approach on how to improve the quality of the built environment (Commission for Architecture and the Built Environment, 2011). CABE identifies 6 priorities when planning for sustainability. A number of sustainability-related impacts occur within the ecological, social and economic spheres when densifying and redeveloping urban areas which are explored below as they pertain to the priorities identified by CABE and which are considered key themes of sustainable planning. The planning priorities are: energy; waste; water; transport; green infrastructure; and public space. The sustainability-related impacts are also explored in relation to increased population.

2.4.1 Energy

Barton (1990) suggests that up to 70% of consumed energy is dependent on land use arrangements. Therefore, the structure of an area has an effect on the energy consumption (Ligmann-Zielinska, Church, & Jankowski, 2005). Some of the energy benefits of urban dense areas according to Paull (2008) are:

- Buildings have fewer exposed surfaces and are consequently more energy efficient. Multifamily buildings consume 20-50% less energy than single family buildings.
- Line-loss is less when electricity is distributed to dense urban areas than to spread suburban areas. Line-loss for electricity has been estimated to be nine per cent of electricity production.

Different structures have effects on the amount of daylight an apartment gets. The Centre for Strategic Urban Research/Center for strategisk byfoskning (2009) identified light infiltration as an important design consideration in densification. The effect of densification must be that new buildings need to be placed so as to get an adequate amount of daylight but at the same time must not ruin the lighting conditions for the old building stock.

Cities and towns have a great opportunity to reduce their carbon emissions by choosing low carbon energy options and energy from renewable sources. Our energy consumption can be reduced with sustainable energy planning and management with low carbon or renewable energy alternative. The benefits will be in less greenhouse gas emission and a more comfortable and healthy environment. Energy bills are reduced with secure renewable energy sources (Commission for Architecture and the Built Environment, 2011).

Energy from renewable sources should be prioritized, and the aim should be to use the most appropriate source within the local area. The design of the energy system should be flexible to be able to respond to new technologies. Energy supply systems are most appropriate in a neighborhood or on a city quarter scale, because if there is a need for switching to another technology it can be done more easily, rather than upgrading each building separately (Commission for Architecture and the Built Environment, 2011).

Thermal master-planning is used to develop energy systems on a neighborhood scale and focuses on using energy more efficiently and avoiding wasting heat. When energy systems are applied in larger scales the economic gain is always bigger than when applied at the single building scale. A well-designed neighborhood has mixed functions, where people can live, work, study and play. With this development new energy system options are available. Local energy use can be evened out between the local buildings that have diverse functions and are used at different times in the day, as energy needs to follow the individual in the local area. Buildings requiring heat should be able to use rejected heat from nearby buildings. An inter-seasonal heat storage system can make this possible. The system can collect heat in the summer time and use it in the winter time, or the other way around, that is, collect cold from the winter to use in the summer. Therefore planners should think of matching buildings in terms of thermal needs when designing a new neighborhood, because by placing buildings requiring cooling against the ones requiring warming an efficient balance between energy uses of buildings is created (Commission for Architecture and the Built Environment, 2011).

The location of the power plant is important to make it the most efficient. Energy from fossil fuels gets lost through transmission; heat is wasted before reaching buildings, because of location. With a local decentralized community energy system the transmission of energy

will decrease and therefore the efficiency will be improved (Commission for Architecture and the Built Environment, 2011).

Distributed energy generation is a system where the energy that is distributed is close to the point of production. A range of technologies can be used in this system providing local energy. The site the energy is supposed to serve needs to be investigated to figure out the most suitable technology to use for the area. Wind turbines work well in windy rural areas and combined heat and power (CHP) technologies work well in dense urban areas with mixed functions (Commission for Architecture and the Built Environment, 2011).

Choices of energy technologies are available at all planning scales, but are usually most effective in regional, city or neighborhood scales. The energy costs are usually related to dwelling type, development type and site characteristics. Site-wide carbons saving technologies have the lowest energy costs. These sites are typically with high density (Commission for Architecture and the Built Environment, 2011).

Solar technologies can provide either electricity or hot water. The electricity comes from photovoltaic cell panels and the heat for the hot water comes from solar thermal panels. The solar thermal technology consists of panels, usually placed on roof tops, which capture the heat energy from the sun and use that energy to produce hot water. The solar panels are easy to retrofit in old houses and can be well designed in new houses. The solar panel technology is easy to understand and therefore has become a popular option of renewable energy. When using this technology, the layout of the panels needs to be considered. The most efficient way is to position them on rooftops facing south where the sun can easily shine on them. The solar photovoltaic technology (PVs) consists of solar cells or solar photovoltaic arrays that convert the sun's energy into electricity. The photovoltaic arrays can be integrated as part of a building's roof. Both solar thermal and solar photovoltaic technologies are most suitable at the building scale (Commission for Architecture and the Built Environment, 2011).

Wind power technology is used to produce electricity. Wind energy captured by wind turbines is converted into electricity. The turbines can be of all sizes; the largest require a lot of land use and produce noise pollution. The wind turbines of large sizes should therefore be best located in rural areas or urban fringes. Wind turbines have to be located in windy spots to be the most efficient. Wind turbines are typically not well suitable for urban areas because of how unattractive they look, land use requirements and wind requirements. Micro turbines, on the other hand, can work in urban areas. Turbines with vertical access require less space and cause less noise pollution. The design and size of the turbines matter when figuring out the best location (Commission for Architecture and the Built Environment, 2011).

There are two basic ways of reducing carbon emission from the energy sector: lessen the amount of energy use and use it efficiently, and use low carbon and renewable technologies. The most efficient way is to do both. With reduced energy demand, the economic gains will benefit the local authorities, residents and businesses as the energy bills will be cheaper. In this way, fuel poverty will decrease and social equity will be greater (Commission for Architecture and the Built Environment, 2011).

Iceland differs a little when it comes to energy because the country already runs mostly on renewable energy. Because of this, energy is rather cheap in Iceland compared to many other countries, which has resulted in wasting energy and not using it as efficiently as should be done.

Table 2: Key points and planning principles regarding energy

Key Points:

- Denser areas have lower energy consumption;
- Low carbon or renewable energy options have lower GHG emission, energy bills, and create a more comfortable and healthy environment;
- Lessen energy use in general and use it more efficiently.

Planning Principles:

- Densify to improve energy efficiency;
- Consider daylight conditions when densifying;
- Use the most appropriate local energy source;
- Design the energy system flexibly;
- Match buildings in terms of thermal needs;
- Choose the most appropriate energy technology.

2.4.2 Waste

Humans produce too much waste and consume natural resources in an unsustainable way. This needs to be changed, by for example reducing waste and making better use of waste materials. Actions such as re-use and recycling need to be interpreted in the field of planning. Sustainable waste planning and management reduce pollution, can create jobs, and provide a low carbon energy source (Commission for Architecture and the Built Environment, 2011).

It is important to place segregation and sorting of waste close to its sources by, for example, having facilities for recycling waste close to every household and business. The facilities for waste management should not dominate the urban area but should be a priority in planning and design of new houses. Waste facilities can be retrofitted to older houses. A network of facilities for sorting, storing, reprocessing and treatment of waste materials need to be planned by the local authorities. Businesses can take on from there for investment and development (Commission for Architecture and the Built Environment, 2011).

In many places, community and voluntary groups are increasingly taking care of waste treatment. The groups are putting a lot of effort in reusing waste, for example by forming furniture reuse projects. The groups emphasize recycling and reducing as well, for example with community recycling companies and paint redistribution schemes. Many groups help local authorities to reach their composting targets and household waste recycling by delivering recycling services to them as part of a contract. With this development the community benefits, as permanent and voluntary employment is being created; more affordable goods with the reuse of things; and the infrastructure and services are improved. Other benefits are: the local economy is being retained and invested in; reduction of CO_2 emissions as long-distance waste management is replaced with local waste management (Commission for Architecture and the Built Environment, 2011).

Underground waste systems can be a good alternative for waste management in high density urban environments. Underground waste collection and storage options operate in 600 neighborhoods around the world (Commission for Architecture and the Built Environment, 2011). A vacuum waste collection system is one of the possible underground systems, as a vacuum is used to suck material deposited via chutes from buildings. When the chambers holding the materials are full the system automatically opens a valve and moves the material to a central bulking facility. This system reduces carbon emissions, improves air quality, and

reduces accidents as it removes the need for collection vehicles. This system also allows flexibility in site layout and design. The system can be retrofitted to existing neighborhoods (Commission for Architecture and the Built Environment, 2011).

The design of new buildings should include waste facilities, and the design of new neighborhoods should include space for waste storage. To be able to calculate required space for waste storage, it is critical to form an effective waste collection strategy which outlines how, where and with what frequency waste is collected (Commission for Architecture and the Built Environment, 2011).

Table 3: Key points and planning principles regarding waste

Key Points:
♦ Recycle and reduce and reuse waste; ♦ High density urban environments have more alternatives for sustainable waste management.
Planning Principles:
♦ Place recycling facilities close to its sources.

2.4.3 Transport

Reduced oil dependency is considered a political necessity because if not we will experience a more dramatic increase in prices than we are already experiencing. Reduced dependency on foreign oil could result in fewer wars. Access to oil in foreign areas is one of the deep and underlying issues causing terrorism and war today. The less oil dependent cities are, the more secure they will become. Overall, by reducing oil dependence, the city becomes a more pleasant place to live. The transportation sector is often considered the most crucial one for action because it has great potential to reduce oil dependency by lessening car use. It is argued that with making cities denser this development can happen, resulting in greater equality and economic gains. Noise pollution will decrease and public safety will increase, the elderly, the poor and the young will have greater walk-ability and access to transit systems. The costs of accidents and pollution will be reduced, all because of oil use reduction Newman et al., (2009).

Newman and Kenworthy (1989) have developed a well-known diagram showing the strong correlation between increasing urban density and decreasing private energy consumption for transportation (Figure 2) (Wheeler & Beatley, 2009). This is a simplified way of viewing it, as additional factors such as the existence of a public transportation system, the number of car owners, etc. will also affect transportation energy consumption. This relationship has been recently supported by Paull (2008), who found that the number of vehicle miles travelled decreases between 20% and 40% as a consequence of compact development. There is, according to him, a relation between vehicle miles travelled, density, distance to city center and access to transit systems. It is quite obvious how density and transportation are connected. Densification and distance to the city center are connected in that densified areas are often located closer to the city center than new sprawl areas. A densified area also often has more mixed usage and thus residents have a reduced need for travel.

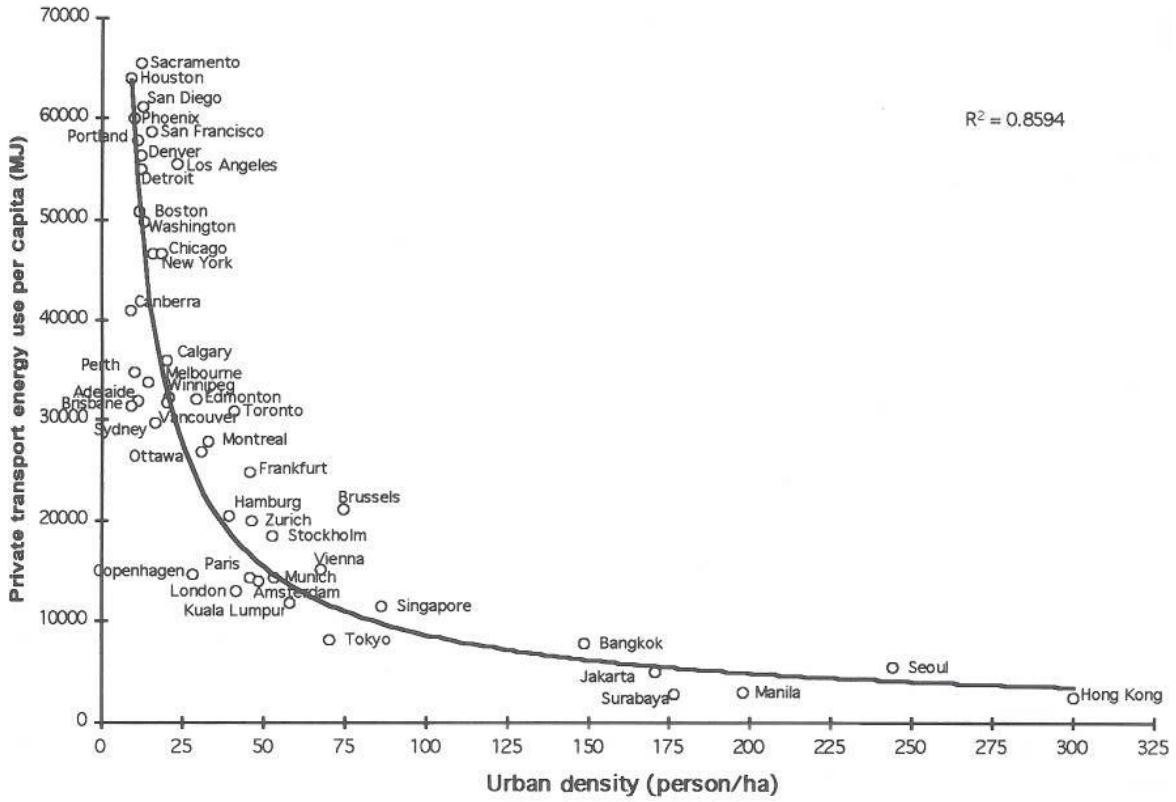

Figure 2: Gasoline use per capita versus population density. Source: Newman, P. & Kenworthy, J. (1989) (Wheeler & Beatley, 2009).

How do people travel? The possible main modes of transportation are on foot, by bike, car and public transportation system. In relation to densification, it is important to accommodate the larger number of pedestrians and bikes that result, which is discussed later in relation to increased population. There are multiple public transportation systems suitable for different densities of people and in different combinations. Rail systems have both the largest capacities and are the most environmentally friendly. People more often choose to use them over going by car compared to other systems, which increases their positive environmental effect (Wheeler & Beatley, 2009). Higher densities in an area can make it economically justifiable to invest in new heavier systems. However, urban densification provides for the opportunity to reuse or intensify the use of the existing public transport system in the area. This will save costs and is considered as one of the benefits of densification (Smith, Clayden, & Dunnett, 2009).

The benefit of having an existing public transportation system is not just related to the financial investment. In the case of new development on the urban fringe (i.e. sprawl), it is often built without connecting it to a public transportation system, making the inhabitants dependent on car travel. The negative environmental effect of this can be illustrated by the following figures: a car can potentially reach 20 to 40 m^2 of area for every mg of CO2 compared to public transport, reaching 800 to 1600 m^2 (Berghauser Pont & Haupt, 2010, p.228).

Modern lives are busy, requiring freedom to move easily and comfortably between home, work and shops. If a car is essential for these movements, the urban design of the place is not good enough. Through sustainable transport planning, the gain is not only in reduced carbon

emissions and economy, but also in improved health and quality of life in general. Urban areas need to be designed in a way that residents have to take fewer and shorter trips, using more sustainable transport options and increase vehicle efficiency and occupancy. Planners need to consider location and connectivity of homes, work places, schools, services, leisure facilities and green spaces to shorten commuting distances. Street pattern and urban design matters to make walking and cycling easy, and to facilitate the use of the public transport system. With this development the air quality improves, fewer road accidents will occur, and there is less cost because of traffic congestion (Commission for Architecture and the Built Environment, 2011).

It is important that the urban environment is developed in a way that encourages people to choose public transport, walking and cycling. Low carbon travel alternatives need to be offered when transport systems are planned. Good and easy connection between places, location of activities and a safe environment are key considerations when developing transportation systems and alternatives. Green infrastructure can be used to link homes, schools, local shops and services. With good urban design people are more likely to walk and bike short distances. With people choosing increasingly to walk and cycle, the benefits are in terms of reduced health problems such as obesity, respiratory diseases, and chronic diseases resulting from inactivity (Commission for Architecture and the Built Environment, 2011).

It is argued that a sustainable mode of travel is encouraged by building places with high densities, with good access to public transport, and with development of existing urban areas. Key planning principles for new and retrofitted development mean developing higher densities. Where access to public transport is good it is advised to build over 30 homes per hectare. Good access to public transport is considered a quality, with poor access to the strategic road network, to reduce car dependency. New urban areas need to have strong linkages to transport routes from the beginning of the development to prevent residents relying on their car from the first day. Traditional neighborhoods with networks of streets tend to be more pedestrian and bicycle-friendly than others. A mix of uses within the neighborhood is crucial, making people able to live close to work and activities (Commission for Architecture and the Built Environment, 2011).

With car-free routes across cities, connecting neighborhoods, people are able to travel longer distances on foot or by bicycle easily. The routes should be connected to transport facilities and include bicycle storage (Commission for Architecture and the Built Environment, 2011).

Table 4: Key points and planning principles regarding transport

Key Points:

- Densify to lessen car use– and oil dependency;
- Close connection between density and fuel consumption;
- Dense cities make heavy public transportations system viable, the most environmentally friendly systems;
- Infill and retrofitting houses make it possible to take advantage of existing public transportation systems.

Planning Principles:

- Densify to take advantage of existing public transportation systems;
- Consider location and connectivity to shorten trips;
- Develop in existing urban areas at higher density to encourage sustainable modes of travel;
- Connect neighborhoods with car-free routes;
- Provide strong linkages to public transport from the beginning of the development to prevent residents relying on their car from the first day.

2.4.4 Water

Sustainable water management minimizes our impact on the water cycle. A safe supply of drinking water is required in modern life, and clean disposal of foul waste. The way we use and manage water does matter. Flooding and drought are probably the worst and most visible effects of climate change. We need to make our places more resilient towards these effects. Water is a valuable design resource; by using water in the urban design it usually increases a place's financial value because of its visual amenity and at the same time addresses climate change (Commission for Architecture and the Built Environment, 2011).

The impacts of extreme weather are uncertain, but obvious flood risk zones should be avoided for settlement. There are usually three types of flood risk zones: *pluvial* an area where there is a risk of surface water flooding; *fluvial* an area where there is a risk of river flooding; and *tidal* an area where there is a risk of coastal and estuarial flooding. Flood risk is considered to be a combination of the probability of flooding and the possible consequences (Commission for Architecture and the Built Environment, 2011).

One of the major effects of compact development is that it sometimes takes place in a green field, resulting in increased surface runoff from a site due to replacement of unsealed vegetated areas with impermeable surfacing and buildings (Smith et al., 2009). Arnold and Gibbons (1996) show a corresponding decrease in storm water infiltration, and an increase in the amount of pollutants in the run-off water. Substituting one impenetrable surface with another (e.g. brownfield development) should not affect surface runoff and the pollution of waterways. Furthermore, the environmental effect on the surrounding area by the new structure itself ought to be negligible. In contrast, building on green space will increase the surface water run-off. Smith et al. (2009) show that this undesirable effect can be countered to some extent by planting new trees in the remaining green space, as trees help to reduce run-off coefficients. The infiltration can also be improved by sinking vegetated areas around paved ones to use them as water catchment areas (Arnold & Gibbons, 1996).

Green infrastructure is an effective approach to surface water management. Open water systems are good for taking care of heavy rainfall naturally. The system helps to take care of the water volumes by slowing it down and letting a more natural response happen. The system is also considered a public enjoyment, as it adds special charm to the area. Green space cover, such as giving buildings green roofs, also reduces surface water run-off (Arnold & Gibbons, 1996).

Natural and sustainable drainage systems (SuDS) are an example of how surface water can be managed. City drainage should flow into a surface drainage system which is designed to be both natural and sustainable. SuDS have many benefits, such as reducing flood risks, cooling the microclimate, reducing greenhouse gas emissions, lowering economic and environmental costs in general and providing opportunities for recreation. The system encourages surface water to remain on site and infiltrate the ground, instead of directing surface water into drains. The system mitigates the effects of storm water run-off on the environment, and therefore it is considered more sustainable than conventional drainage methods. The system slows down storm water; protects and increases surface water quality; improves recharge of the ground water; increases the area's wildlife; and adds a special charm and comfort to the area (Commission for Architecture and the Built Environment, 2011). By integrating water management into building and site design, the flood risk in areas is minimized and the value of the place is enhanced.

When planning along rivers and coastlines, flood risk management is needed where strategic environmental impact needs to be taken into account. PPS25 is a planning policy statement that requires planning authorities and developers to be sure to take flood risk into account at all stages of planning processes; avoid and direct inappropriate development away in flood risk areas; ensure that climate change is considered when new development takes place and does not increase flood risk elsewhere. PPS25 identifies four key principles to approach surface water run-off and flood risk: possible risk of floods because of surface water need to be assessed; SuDS should be used to avoid risks from surface water and the location of new development should be away from risk areas; place more vulnerable development in lower risk areas; use SuDS to control and reduce flood risks (Commission for Architecture and the Built Environment, 2011).

Table 5: Key points and planning principles regarding water

Key Points:
♦ Water is a valuable design resource; ♦ Avoid settlements on flood risk zones.
Planning Principles:
♦ Design areas with open storm water systems, or SuDS; ♦ Give buildings green roofs.

2.4.5 Green Infrastructure and public space

Green infrastructure includes trees, parks, gardens, road verges, cemeteries, woodlands, rivers, wetlands and coasts, a living network around and beyond urban areas. Green infrastructure has multiple functions, offering sustainable alternatives. It protects urban areas from flooding with green roofs and large trees taking care of heavy rainfalls; stores and recycles water; saves energy as, for example, green roofs and trees in isolation; offers places

for exercising and socializing; gives places character and a strong identity; and allows people to access nature and feel a part of it. Planners need to be aware of the benefits of green infrastructure, protect local green spaces and integrate green infrastructure into the design of buildings and places. In this way the image of the place is improved, property prices are boosted and investment attracted (Commission for Architecture and the Built Environment, 2011).

Public spaces can be streets, squares, parks, or other places that are accessible and open to everyone. The open spaces of a place are what it makes it unique and a part of the place's character. Well-designed and managed public spaces are important for the place; the quality plays a major role in economic, social and environmental sustainability of our communities. They should be designed in a way that encourages social interaction and attracts people to be there and enjoy a more outdoor lifestyle. The places should be ideal for restoration, reduce stress and adapt to changing climate. The public spaces should be looked on as assets of the place (Commission for Architecture and the Built Environment, 2011).

Valsson (2000) writes about the importance of including nature in the urban design of cities in his book *City and Nature*. Planners should look at contrasts as a concurrent unit, he says, making each other stronger. To explain in more detail, Valsson (2000) takes an example of a house and a garden designed together; the house becomes more interesting because of the garden and vice versa. The same principle goes for urban design of a city; by including nature in the urban design, the place is designed on a higher level. By placing a small core of the contrasts within each other a balance is achieved. For example, where land is by the sea a balance between the land and the sea can be made by placing small islands in the ocean and having small ponds on the land.

In the compact city, the built environment first and foremost has a larger impact on the ecology in the urban area. However, the ecological effects of infill and retrofitting densification differ depending on the type of land used, whether it is green space or an already paved surface, like a parking lot, used for development. If development occurs in green space, more impervious coverage may be added to the ecosystem.

The growth policies that encourage urban "infilling" may result in higher inner-city imperviousness in order to reduce sprawl and overall imperviousness, region-wide (Arnold & Gibbons, 1996). It could therefore be argued that compact development results in more "saved" green space in the region as a whole and leaves virgin land untouched. Paull (2008) and Smith et al.(2009) also argue that land on the city edge is saved by infill development, preventing sprawl.

Another effect from building on green space is related to the disappearance of the green space itself in the urban area. An important feature of environmental sustainability in an area is biodiversity, which is directly related to the green space in the area. Urban biodiversity depends upon a number of factors including the structural variety of vegetation, the number of plant species present, the existence of mature trees in the area, the spatial distribution of the green space, the amount and size of vegetated areas, etc. (Smith et al., 2009; Ligmann-Zielinska et al., 2005). The result of densification on green space is that buildings replace green areas, thus decreasing the biodiversity in the area. Depending on how the green space fulfilled criteria for biodiversity, the effect of its removal will differ. To counter the negative effect on biodiversity, the structural variety of the remaining green space could be improved by planting trees or bushes, or giving the new building a green roof or a green wall. The trees

would, as they mature, also improve biodiversity by their very existence (Ligmann-Zielinska et al., 2005). If the trees are planted close enough, they can also help create green connectivity through a site (Smith et al., 2009). The number of plant species in the surrounding area could also be increased. The overall effect on biodiversity would then hopefully be somewhat negated.

Research has shown a positive effect of green space on health. Two such ways are represented in trees and gardens. Keeping existing trees and planting new ones in an area being densified have many positive effects related to sustainability, as listed by Smith et al. (2009): trees affect energy consumption, ecological function, and the health and the well-being of the residents. Trees also improve air quality by filtering noxious exhaust gases and absorbing air-borne particulates. They cause pleasant noises such as creaking branches and birdsong, help the formation of cognitive mental maps, the symbolic presence of nature and increased opportunities for play. Furthermore, the visual quality of residential streets increases with tree canopy cover.

Private garden space may be reduced or removed by infill development. This space, however, has many important effects on health, well-being and the environment. In dense areas there are few single family houses, and this leads to a loss of lifestyle choice and decreases the number of private gardens. A number of benefits from private gardens can be mentioned, such as opportunities for self-expression, including safe children's play, health, therapeutic and restorative benefits, alternative sources of fresh food and opportunities for composting, reducing the amount of biodegradable waste (Smith et al., 2009). On the other hand, decreasing the number and size of private gardens may adversely affect biodiversity in the city, but biodiversity as a whole will profit by more virgin land left untouched. The remaining green space can be enhanced with plantings that raise biodiversity and by permitting residents to participate in cultivation.

Densification and green-space can have an effect on the local climate in terms of temperature and wind. Air temperatures in dense urban areas are elevated compared to the surrounding countryside and this temperature increase can have a negative impact on human comfort and health (Pauleit, Ennos, & Golding, 2005). Making cities denser is likely to increase the ambient temperature. On the other hand, adding vegetation will shelter buildings from wind and thereby reduce energy consumption attributed to heating (Smith et al., 2009).

Table 6: Key points and planning principles regarding green infrastructure and public place

Key Points:

- Green infrastructure and public places are important in urban areas;
- The amount of impervious surface is an indicator of environmental sustainability;
- The biodiversity depends on the quality of the green space;
- Green space and trees in particular have all sorts of positive effects on the environment and human health;
- Infill and retrofitting development is sustainable because it spares virgin land at the fringe of the city.

Planning Principles:

- Use already paved surface for development when possible;
- Compensate for reduced green space by developing remaining space, for example by planting trees or give buildings green roofs;
- Include nature in the urban design of cities.

2.4.6 Population Increase

Increased population resulting from densification has negative environmental effects, as a larger population in the same area will mean more pressure on the local ecosystem. The area needed to supply the resources and handle the waste produced by people living there (i.e. ecological footprint) is always larger in an urban area, and it will increase with an increase in population. An apparent disadvantage to densification is this increased ecological footprint (Wheeler & Beatley, 2009), but in relation to the higher population, the footprint per capita may actually decrease on the whole.

Another aspect of the sustainability problem is the urban metabolism (Wheeler & Beatley, 2009) of the area. The urban metabolism will increase with more inputs in forms of water, oxygen and added resources needed, and more outputs produced in the form of waste, wastewater and other pollutants. One example of this is more traffic and an increase in air and noise pollution in the area as a result of densification. This effect has to be weighed against the effect of building on virgin land, which might generate even more traffic and pollution as well as ruining that land. One of the most problematic aspects of the increasing metabolism is that it is linear, meaning its outputs are not inputs to any other system and, thus, they stack up. With densification, the waste mountain produced by the area increases. By densifying, one could argue that it is more rational to handle more waste at the same place, not least because of the opportunity to transform streams from linear to closed loop systems.

Population increase has a positive social effect in terms of safety and community. According to Jan Jacobs (1961), streets and sidewalks are the city's most vital organs, and more “eyes upon the street” make for a safer street. She also notes that unpopular parks experience the same negative effects as empty streets, and are more prone to vandalism. Densification will add more people to the same street network, increasing the pedestrian traffic and low-intensity social contact (Wheeler & Beatley, 2009) occurring therein, which leads to wider social networks.

A common result of densification of an area is that it becomes gentrified. It is positive for the area to become more attractive but it could be considered as a social problem that current residents might have to leave the area if the increased attractiveness makes it too expensive.

According to Paull (2008), infill development generates economic vitality, and Dorsey (2003) suggests that there is great potential for new ecological growth and sustainable economic development through infill. As well, Jane Jacobs (1961), states that "commercial diversity is, in itself, immensely important for cities, socially as well as economically." Therefore, increased population fosters diversity and economic vitality. The added population will become new customers for local shop owners, and hence they can expand the range of supplies and services they offer. Establishment of new types of commerce might also be possible. The larger workforce living in the area might make it more attractive to companies for investment. As a result of the population increase, more services like schools, day care and health care might be needed. A larger population base also makes it easier to finance such demands locally, as the tax base of the area increases.

Table 7: Key points and planning principles regarding population increase

Key Points:

- Increasing population in an area has a negative effect on the local environment but densification in general has a positive environmental effect on a global level;
- Positive social effects result from having more people in public spaces, improving social networks;
- Increased population facilitates economic opportunities.

Planning Principles:

- Densify, while respecting the local environment, to improve the social and economic climate.

2.5 Stakeholder Involvement

Up to now a range of sustainable planning principles have been identified. One of the most challenging things in planning is probably how to include and consider all the different stakeholders in the planning process. This is important, and this section explores how collaborative planning processes can help.

Collaborative planning processes are used more and more in the field of planning today. When developing a plan for a neighborhood, a city, or a region, it affects many as diverse stakeholders. Planners are aware that their plan making can influence different stakeholders. A plan is not made to please one person but to please as many of those affected by the plan as possible. The diverse interests of the stakeholders can cause possible conflicts. To please all the stakeholders, take their interests into account and deal with possible conflict is one of the hardest tasks the planners are facing.

"People have a democratic right to be involved in decisions that affect them" (Connelley & Richardson, 2004, p. 8). The importance of involving the general public and stakeholders in the planning processes today is obvious. The task can be hard to handle because of the different interests held by the stakeholders. Planners endeavor through their planning processes to create a proper community. Watson (2003) argues that creating a proper community is a technical, moral and political task. The way to create this proper community is by using decision-making processes, involving people and stakeholders that the decision affects. But how can planners reach a decision that pleases all the different stakeholders, with different interests and possible conflicts? Watson (2003) argues that decisions can be reached through collaborative planning processes involving the stakeholders. By using a collaborative

planning process, fair, equal and empowering participation can be established. The collaborative processes are designed to overcome community divisions and reach consensus on planning issues. One identified problem of collaborative planning processes is that planners tend to make assumptions that can possibly be wrong about the values, beliefs or rationalities of those they are planning for. Exploring similar examples of planning intervention which show diverse rationalities and interaction between stakeholders in a planning process is one way to prevent this from happening (Watson, 2003).

Decision-making processes can be used as an approach to deal with conflicts between stakeholders. Through public involvement citizens and other stakeholders engage with the traditional institutions of government. The planning process is designed to encourage development by bringing different interest groups to the planning process as partners. By doing so the aim is to reach an ideal outcome, involving an agreement between all stakeholders. But that is not always the case; sometimes the outcome of the collaborative processes leads to greater conflicts between stakeholders (Connelley & Richardson, 2004).

Forester (2006) investigated in his article how to make participation work when interests conflict. His article took on a case where there were huge conflicts between angry stakeholders. The planner approached the stakeholders from an optimal perspective, making them work together and focusing on common interests. By informing the stakeholders, they became more open minded and achieved a better understanding about each other's issues and interests. Through his strategy, the stakeholders' conflicts were resolved and a decision was made which all the stakeholders agreed upon (Forester, 2006). Forester's (2006) article is an example that shows that conflicts can be resolved and an outcome that pleases everyone can be reached in collaborative planning processes.

Connelley and Richardson (2004) identify another problem of collaborative planning processes; exclusion of people, issues, or outcomes. Because of how difficult it is to establish ideal stakeholder involvement in the decision-making processes, it is important for the practitioners and researchers to make the key decisions consciously and transparently (Connelley & Richardson, 2004). Rydin (2007) argues that knowledge plays a big role in planning processes. The planner is the holder of multiple knowledge, professional knowledge and knowledge coming from stakeholders. The planner needs to be a good listener, and listen to unheard voices to get as much knowledge as possible. It can be challenging to gain much knowledge and recognize its values.

Table 8: Key points and planning principles regarding stakeholder involvement

Key Points:
♦ Planning influences many stakeholders and should aim to please all of them- which is one of the hardest tasks in the field of planning; ♦ Planners become more informed by including stakeholders.
Planning Principles:
♦ Involve stakeholders in the planning process; ♦ Bring different interest groups to the planning process as partners; ♦ Find common interests; ♦ Inform the stakeholders; ♦ Include all stakeholders and listen to all the voices.

2.6 Sustainability Projects

The technology and knowledge required for sustainably developing cities exists and has been proven to work in many sustainability projects around the world. This development is being accepted worldwide with some cities ahead of others. Many sustainability projects of interest have been developed using many of the identified planning principles in this thesis. Two of these projects are located in Sweden and will now be introduced. The projects can relate to the thesis's Case Study, the ERB Area, because of similar situations.

Hammarby Sjöstad

Hammarby Sjöstad is a quite new district in Stockholm with a strong emphasis on sustainability, using environmental innovations such as community energy systems and vacuum waste systems. It is an example of how sustainable infrastructure for transport, waste, and energy can be integrated in new developments in a successful way (Commission for Architecture and the Built Environment, 2011).

Hammarby Sjöstad used to be an industrial site but has been cleaned up and redeveloped into an eco-friendly area (Figure 3). The area is considered to be the largest urban development project with its own environmental program. The program's main focus is on energy supply, water treatment and waste management. Former industrial buildings have been given new uses and transport barriers have been broken. The area is located quite centrally in the city and considered to be a natural extension of the city center. The area is densely built with mixed uses, buildings diverse in type and ownership. There are many transport options, with car-pooling, ferries, trams and buses connecting the area to other parts of Stockholm. This former brownfield now consists of an attractive residential area with charming parks and open spaces (SymbioCity).

Figure 3: Hammarby Sjöstad is a former industrial area by a waterside similar to today's ERB Area. Hammarby Sjöstad has successfully been redeveloped into an attractive mixed-use dense residential area (Fristedt, 2010)

An eco-cycle system in the district, called the Hammarby model, aims to make the residents produce half the energy they need by themselves, focusing on renewable fuels, re-use of waste heat, biogas and household energy efficiency. A thermal plant is located in the area

that extracts heat from treated wastewater and contributes by-product energy to the district cooling network. Another co-generation plant separates combustible waste, using it as an energy source for electricity and district heating. The district uses centralized production of heating and cooling technology and solar panels. The system also includes all storm water, rainwater and melt water (SymbioCity).

Hammarby's main sustainability factor is the unique Hammarby model, which handles local energy, waste, water, and wastewater. The design of the area also aims to provide a healthy environment, with opportunities for exercising, sport and local culture (SymbioCity).

The Bo01 Area

The Bo01 Area is an eco-city in Malmo, which is a medium sized city in the South of Sweden. The former industrial city has been developed into a dense and compact biking city. The city in general can be inspiring for sustainable development in Reykjavik because it is closer to Reykjavik in both population and size than, for example, Stockholm (Malmö Stad).

The Bo01 Area is a new district (Figure 4), located close to the city center in the Western Harbor in Malmo with 600 inhabitants mixed with offices, shops and other services. The Western Harbor used to be an industrial area but has been transformed into a sustainable living area, with parks, swimming areas, schools and accommodation (SymbioCity).

Figure 4: The Bo01 Area is a former industrial harbor site, similar to the ERB Area, and has been successfully transformed into a charming dense mixed-use residential area (Jack, 2007).

The development of the Bo01 Area was approached through ecological planning. Sustainability inspired the architects of the area. Tall buildings are located in the outskirts of the area to provide wind shelter. Former industrial buildings were transformed into new uses. The houses of the area are various in types, both in looks and ownership. By doing so, the aim is to contribute to more social equity, which is one of the three aspects of sustainability (SymbioCity).

The area has its own energy supply and waste treatment system. There is a waste source-sorting system close to every home. When redeveloping the area, some of the green space was lost. Steps were taken to compensate for the lost green space, for example, by giving some of the buildings green roofs and walls. The result is that the area has varied and rich green space which promotes biodiversity and better health of the area's residents and visitors. The green roofs and walls also handle storm-water well and have positive effects on the local

climate. The area has an open storm water system consisting of canals, ponds and fountains, which are both beautiful and good for the environment. The area is successfully designed to minimize car use. The area has close access to goods and services, bicycles and pedestrians have priority in traffic, and the area is well connected to other parts of the city with busses. Most of the residents who own a car park them outside the area and walk to their homes. The residents of the Bo01 area are satisfied with this development, which has made the area almost car free (Malmö Stad).

The Bo01 Area and Hammarby Sjöstad projects are inspiring for redeveloping the ERB Area in Reykjavik, especially because the areas have many similarities. This thesis identifies the first step in the sustainable development of Reykjavik as a city having higher density. By doing so, the aim is to tackle the most urgent local sustainability issues: the country's car dependency and health issues resulting from inactivity. The next chapter presents a planning proposal for the ERB Area, using the earlier identified planning principles.

3 Part B: A Case Study: The ERB Area

By making use of the identified planning principles in Chapter A, Reykjavik can be moved towards being planned and developed in a sustainable way. With sustainable development the city becomes in many ways, a better place to live in. Today's car oriented transport sector is the most worrying part of the greenhouse gas emissions profile in many cities. Places with few cars encourage people to walk, cycle and use the public transport systems more. With this development health problems impacted by the lack of physical activity will decrease.

This chapter consists of a Case Study. The sustainable planning principles from Chapter A are used to develop a plan proposal for the redevelopment of the ERB Area in Reykjavik.

3.1 Analysis of the Case Study

The ERB Area is located on Reykjavik's North shore. The analysis begins with an introduction to the area's place in the North Coast development of Reykjavik, followed by a description of the area; the identification of the main issues, and introduction to the area's current plans. Later, marketing measures will be introduced and a plan proposal for the ERB Area, followed by discussion and conclusions.

3.1.1 The Area's Place on the North Coast of Reykjavik

History

Valsson (2000) tracks the development history of Reykjavik and identifies that the North Coast is suffering most from dirty industries and poor planning connections. Mostly since the Second World War, humans have tended to ignore the laws of nature by putting nature in second place after the built environment. Reykjavik's coast has suffered because of this attitude, especially the North Coast. The coastal areas developed with industrial functions and later highways separating them from city life. As the years passed industry along the coast got denser and traffic on the coastal highway increased, resulting in a decreased relationship between the neighborhoods along the coast and the ocean. With this development, carbon emissions and the volume of sewage released increased along the city's coasts, making them unattractive.

The first planning draft of the city was made in 1927. There the North Coast was mainly planned for industries and commercial premises. This was not surprising because of the dominant importance of the fish industry at the time and the North Coast had many qualities for harbor related uses. Later, a plan was made in 1948 where the whole North Coast was developed only for industrial and harbor areas. This plan proposed no recreational or residential areas on the North Coast. The result of this is that the North Coast today has only one accessible recreational area for the general public, called Laugarnes. Not only was the coastal line filled with dirty industries in this development process but crude waste was also

released into the ocean and every beach was filled with construction waste disposal. Many valuable and beautiful areas were destroyed (Valsson, 2000).

Reykjavik's South Coast was popular for bathing until 1960, which connected it in some places to city life. In the following years the beaches became unsuitable for bathing because of the high sewage emissions caused by the drains that opened out onto the beaches (Valsson, 2000).

In the late 20th century people's knowledge of environmental issues increased. Effort was put into cleaning the coasts and in creating connections to urban areas, for example with pedestrian paths along the shore line and by removing dirty and unattractive industries from the coasts. With this development the coast and the urban area were no longer regarded as separating contrasts but instead as a single contiguous unit. After cleaning the coasts the bathing spot Nautholsvik has become popular again (Valsson, 2000). Parts of the coasts have a great potential for further positive development.

Waterfront development

According to Valsson (2000) in shore line development it is important to: Keep the beach open to the general public; planners should, for example, avoid placing single family houses at the shore line to ensure access for everyone; Place activities at the shore line to connect the residents and visitors to the ocean, by having, for example, water-related activities. These principles are similar to the Washington State Shoreline Management Act (SMA) of 1971 which was enacted by the US State of Washington. The Act promulgates the three most important considerations of shoreline development: use of the shoreline, environmental protection and public access. The shoreline's uses should result in minimum pollution to prevent damage to the environment. Preferred uses are mainly water-dependent, water-oriented or water-related. Shorelines should be accessible for the general public; everybody should have the opportunity to enjoy them. A shoreline's natural resources, land and aquatic wildlife should be protected (Department of Ecology State of Washington).

The areas where ocean and a city come together are probably the most valuable urban areas. Waterfront developments have become popular in many cities. Old harbor areas mainly used for trade are brought back to life, with interesting developments which citizens enjoy. People are drawn to watersides and enjoy living and spending time close to water, making these areas extremely popular to live in and visit. Recently there have been many great and successful waterfront developments, such as the sustainability projects in Sweden already mentioned: Hammarby Sjöstad in Stockholm and the Western Harbor in Malmö.

Reykjavik recently started to fallow this trend of waterfront development, with new constructions in the old harbor area downtown in Reykjavík. Harpa is a concert hall and conference center located in Reykjavik's old harbor (Figure 5ab). In 2002 it was decided to build this conference and music center which started operations in the spring of 2011. The intention is to bring life to the old harbor with strong connections to the city center (HARPA TÓNLISTAR- OG RÁÐSTEFNUHÚSIÐ Í REYKJAVÍK).

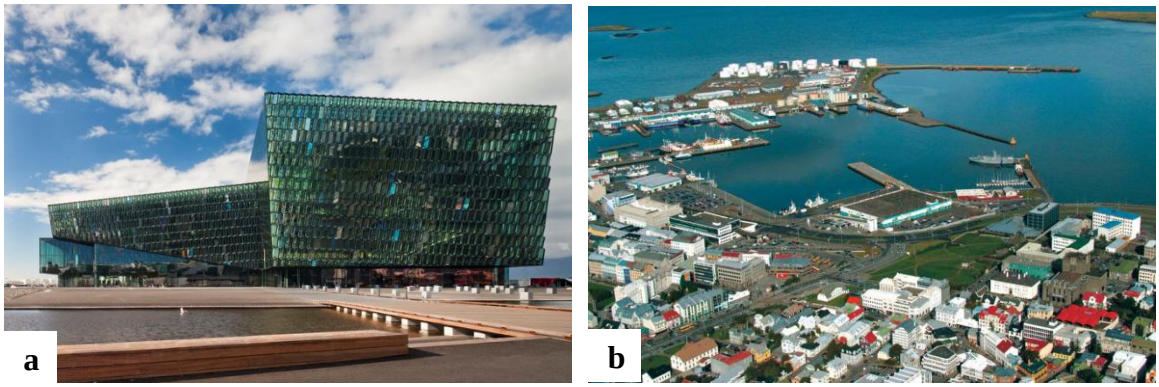

Figure 5ab: Figure a is the Harpa Conference and Music Centre. Figure b is Reykjavik's Old Harbor, where Harpa is located. The figure shows also a part of the City Center (HARPA TÓNLISTAR- OG RÁÐSTEFNUHÚSIÐ Í REYKJAVÍK).

This development has been a success, with small businesses popping up in the old fish factories and warehouses along the Old Harbor close to Harpa, such as restaurants, coffeehouses, design shops, and tourist attractions such as whale-watching trips and old boats transformed into restaurants (Figure 6ab). Traffic calming techniques are used to break the connection barrier Saebraut, which otherwise would separate the Harbor Area from the City Center. This site of the town is now popular to visit, to enjoy a meal or a cup of warm beverage with a great view of the ocean.

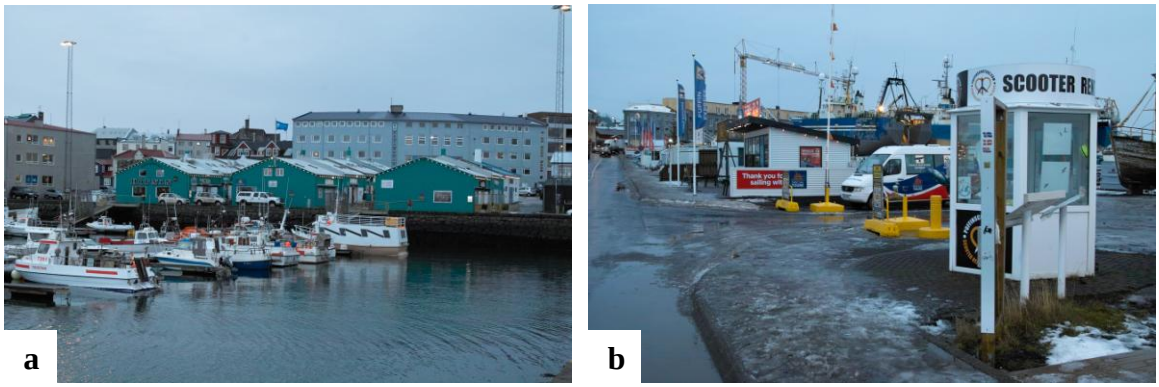

Figure 6ab: The Old Harbor in the City Centre has become popular for people to visit, with coffee places, restaurants, tourist attraction, etc., figure a and b. Old fish factory buildings have been given new uses, figure 4a.

Waterfront areas are valuable but can also be vulnerable, for example because of changing climate that will lead to sea level rise and thus increased risk of ocean floods that are a threat to many waterside areas. This is why it is important that planners are informed of the threat that climate change is to these areas and use sustainable planning principles to develop the areas to make them less vulnerable. The technique and the knowledge of how to develop urban areas in a sustainable way already exist. Now is the opportunity to use these techniques and knowledge to redevelop parts of Reykjavik's coastal lines into charming residential areas with fun activities, where people can enjoy being outside in a natural environment. The ERB Area is probably the most suited area to start this development, with interesting natural and landfill opportunities.

3.1.2 Overview of the ERB Area

The ERB Area's place in Reykjavik

The aim of the North Coast development (Figure 7) should be to create an attractive outdoor environment with good connection between the coasts and city-life. This can be done by placing residential areas with attractive outdoor activities. For this to happen landfills must be made and dirty industries, as well as uses with no relation to the shore, removed. The highway Saebraut is a big barrier in redeveloping the North Coast (Valsson, 2000). This barrier can be broken by, for example, having pedestrian tunnels or bridges. Traffic calming techniques can also be used.

Valsson (2000) identifies the ERB Area as one of the most ideal areas placed on the North Coast for redevelopment because of the area's natural beauty and uniqueness. The area is considered ideal to connect the North Coast to city life. Valsson (2000) argues that residential areas on coastal lines should be placed where opportunities for outdoor and water-related activities are plentiful. In this way contrasts can benefit each other as the coastal line becomes more beautiful because of the built environment and vice versa. The ERB Area is ideal for this kind of development. A small residential area already exists within the ERB Area, called the Harbor Area (Bryggjuhverfi), which was the first neighborhood in Reykjavik designed for the purpose of enabling the residents to enjoy the ocean.

The ERB Area is located centrally in the eastern part of the city on the North Coast of Reykjavik (Figure 7). The ERB Area is a district physically defined by the ocean to the north, and heavy arterial roads to the east, south, and west.

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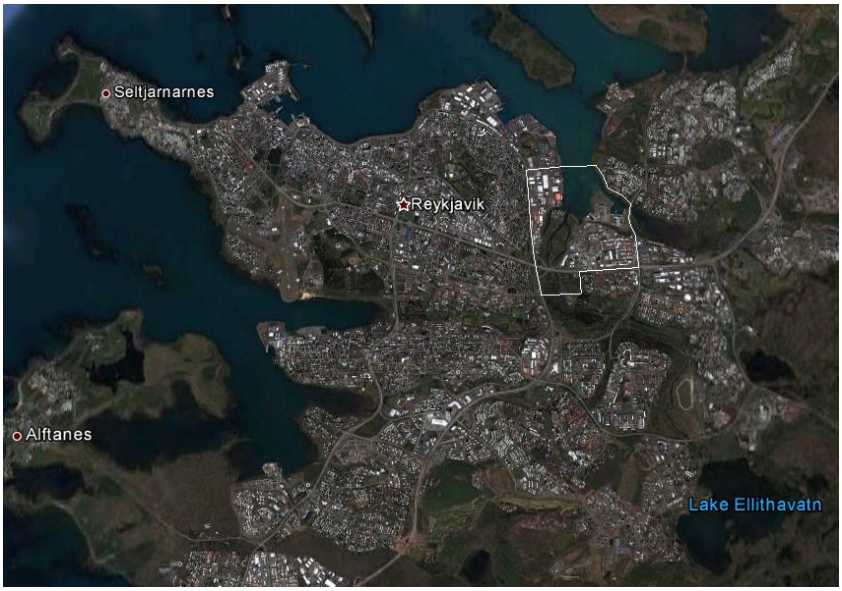

Figure 7: The case study, the ERB Area, is shown with a white frame in the figure. The ERB Area is located centrally in the eastern part of the city by the North Coast (Google, 2011).

Today the ERB Area is a little strange as it has so much natural beauty, with a vivid and diverse landscape, the Ellida River running through, which is a salmon river, and a great view to the island of Videy and the city's famous mountain, Esja. At the same time the area is

unattractive because of the big undeveloped open spaces; land requiring commercial premises; and dirty industries which have ruined some of the area's natural beauty (Figure 8). The area has also two marinas and the residential neighborhood of the Harbor Area, which should be attractive but is not at all as the neighborhood is surrounded by the area's industries and poorly connected to nearby neighborhoods. The only practice which is restricted to this area in Reykjavik is allowing dogs to run free, a practice that is forbidden elsewhere in the city. The existing road system within the area needs almost no further development in some parts, but some changes are needed in other parts. Therefore, the existing road system can partly be used when redeveloping the area. The area is also well connected with the city's main traffic roads on borders. In general, the area has great potential in being redeveloped into a charming site in Reykjavik.

According to the current Reykjavik General Plan (Reykjavíkurborg, 2006), the area has been on the agenda for redevelopment for some time. The new proposed General Plan of Reykjavik identifies the ERB Area as one of the seven key districts for developing a denser city. The main qualities mentioned when identifying the ERB Area as a key area for redevelopment is the area's location in the city, the natural beauty of the area, and convenient road connections.

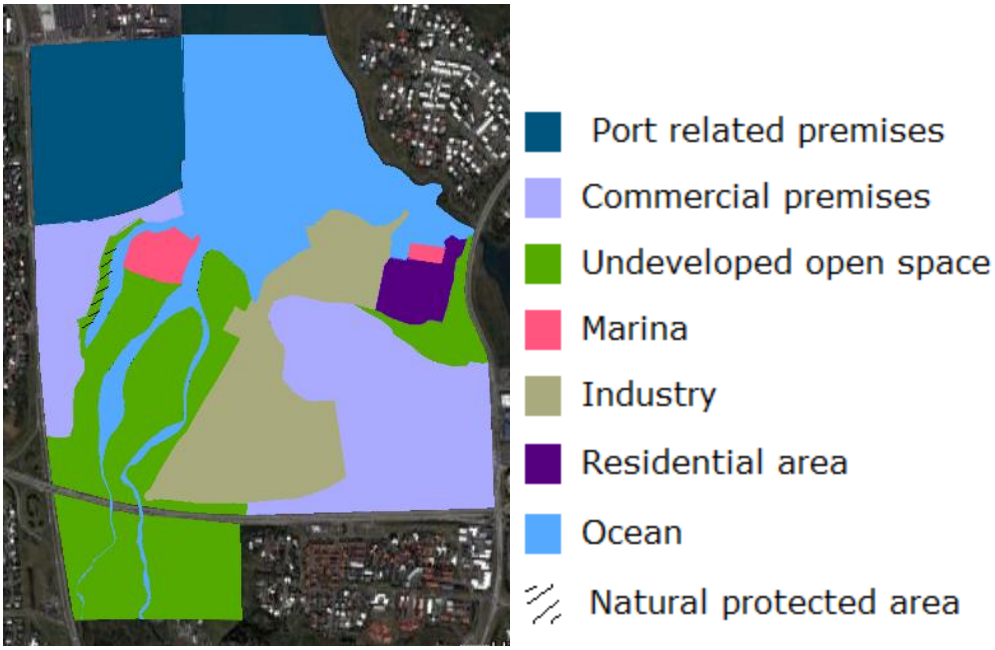

Figure 8: Today's functions in the ERB Area (Google, 2011).

The neighborhoods surrounding the ERB Area are mainly residential to the west, south, and northeast, and industries and commercial premises to north and east (Figure 9). The Ellida River Valley to the south of the ERB Area is one of the city's s recreational pearls and one of the most popular recreational areas in Reykjavik to visit. The Valley is beautiful with diverse flora and fauna, with a range of different plants and various kinds of birds and fish.

The geology of the area is interesting and the place has a history. What makes the area most charming is probably the Ellida River running through it. The Ellida River has its origin in Ellida Lake (Figure 7). The river runs 6 km along its almost untouched channels, through the

Ellida River Valley and the ERB Area and from there into the ocean (Hjartarson, Sigurðsson, & Vilhjálmsson, 1998). The river is a popular place for fishing, as it contains salmon. Other outdoor activities taking place in the Valley are horseback riding, running, cycling, and walking paths, and a ski lift is placed in the area's hills.

Figure 9: The ERB Area's surrounding functions. The ERB Area is marked with a white frame (Google, 2011).

Current Built Environment

The built environment of the ERB Area consists of functionally separated zones: a shopping center at the southeast corner; office buildings to the south, east and west; the small residential neighborhood, the Harbor Area, to the northeast; undeveloped open space in the middle; and the rest of the area is mainly harbor related with industries requiring land. The area, on the other hand, lacks services and commercial functions. In general, the area is pedestrian unfriendly except in the open space which has some paths. Some of the industrial buildings have an interesting look such as the tanks and the barracks (Figure 10). The barracks are quonset huts left from the Second World War and therefore might have some cultural value, but they are in rather bad shape and might be hard to transform into new uses.

Figure 10: Many of the buildings in the ERB Area have an interesting look and can possibly be used for new functions. 8a: A view to two of the tanks: 8b and 8d: The barracks; 8c: Buildings in good shape.

The buildings in the Harbor Area are different from most other buildings in Reykjavik, in color as well as in style (Figure 11). The Harbor Area has obviously been designed to have mixed functions, with some of the buildings housing services or commercial functions on the bottom floor and residential use on the other floors. Currently the neighborhood is too small to support necessary services and shops and poor connections to the surrounding neighborhoods makes it a bit isolated as a residential area. However the neighborhood has great potential for further development which is enhanced by the marina and other unique features.

Figure 11ab: Pictures of the Harbor Area. Some of the buildings were designed to have mixed use function, figure 8a. The only function other than residential found in the neighborhood is a car dealership located on the ground floor of one of the buildings, figure 8b. The buildings are unique in looks.

Transport and connections

The city's bus system is today not serving the ERB Area properly. Only one route drives through the area and another barely enters the area (Figure 12). There are good connections on the surrounding highways though, so it should be easy to add more bus routes to the area.

Figure 12: The city's public transport system. The ERB Area is marked with a yellow frame. The blue route drives though the area and the green route barely enters the area. Many of the routes drive along the surrounding highways however (Strætó bs.).

The barriers to connections within the area are mainly natural barriers, such as the ocean, the Ellida River, and the steep slopes. The open space can also be looked at as a barrier, because of its size and lack of attraction. The biggest roads within the area are Saevarhofdi and

Sudarvogur, which can possibly also act as barriers, depending on how they will be redeveloped. Saevarhofdi divides the area. The main barriers to connections from the area to nearby areas are the ocean and the three heavy traffic arteries: Saebraut, Vesturlandsvegur, Hofdabakki/Gullinbru, surrounding the area (Figure 13).

Figure 13: The main barriers within the area and to other areas in the city (Google, 2011).

3.1.3 Issues

Land use

Harbor Town has great potential for building new houses, as the neighborhood is not populated to its current capacity. One of many of the ERB Area's industrial companies requiring a lot of land is located next to the Harbor Area (Figure 14). With those companies gone many opportunities are created, both for enlarging the Harbor Area and for redevelopment in other parts of the ERB Area.

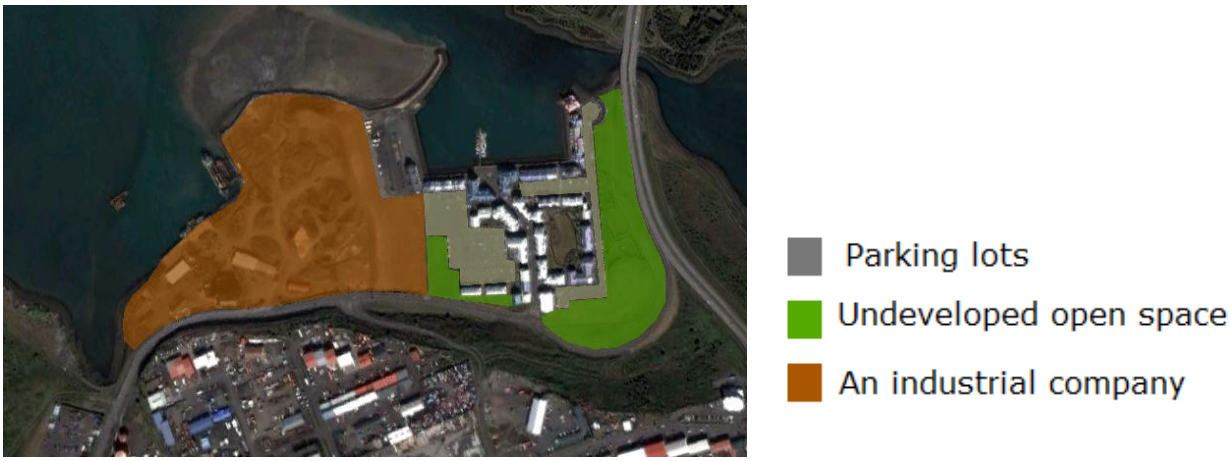

Figure 14: The Harbor Area has great potential for sustainable densification with constructions on parking lots and undeveloped open space. With the industrial company next to the neighborhood gone possibilites for enlarging the neighborhood are created (Google, 2011).

With the industry and commercial premises requiring a lot of land removed from the ERB area, a great opportunity would be created for retrofitting new buildings and urban infill. The current infrastructure and open space are not being utilized by residents to intended levels. The ERB area is ideal for urban densification to maximize land use efficiency. A denser urban environment would lend the area to various sustainable infrastructure options and give it a feeling of urban vitality. Building types can blend residential, commercial, office and services uses and in some parts bring businesses to the street front and informal social interaction to the sidewalks. Jane Jacobs (1961) tied the varied schedules of inhabitants in mixed use environments to more efficient uses of space and fewer dead hours, contributing to a livelier urban environment. Furthermore, she states that diverse building uses, can serve a greater variety of consumer needs through the various periods of the day.

Brownfield and Greenfield

Land use can be maximized by building on parking lots and along roads where current green space is inefficient. Research has shown that parking lots are the biggest source of pollutants to storm water (Bannerman, Owens, Dodds, & Hornewer, 1993). Underused green areas with low ecological value should be developed while green space is consolidated in other areas and planted to provide greater biodiversity and ecological and social benefits. Some of the green space in the ERB Area should be maintained and developed as high quality green space.

Retrofitting of buildings and infill development should seek first to mitigate the impact of paved surfaces and underused lawn areas. New and existing buildings can include green roofs to decrease the percentage of impervious surfaces in the neighborhood. According to Arnold and Gibbons (1996), "impervious coverage /…/ is both a reliable and integrative indicator of the impact of development on water resource," so by reducing impervious surfaces, the hydrology of the area will be restored. The ERB Area should not have any problems making use of this principle because the area consists of a lot of impervious surfaces, such as big parking lots, ideal for construction, for example, for retrofitting houses. Valuable green areas are to be found mainly along the Ellida River, and the ocean. Other green areas are probably of low value and can be used for new construction.

Transportation

Although the ERB Area is well connected with the surrounding traffic roads, the area becomes isolated because of them as well. Reykjavik's biggest road intersection is on the fringe of the area, a huge four leaf clover shaped intersection requiring a lot of land (Figure 15). The intersection connects Saebraut and Vesturlandsvegur on the west fringe of the ERB area. This road system is extremely pedestrian and bicycling unfriendly.

Figure 15: The four leaf clover road intersection on the ERB Area's fringe is shown with a red frame; the white frame is the case study area (Google, 2011).

The roads surrounding the ERB Area are close to reaching their maximum capacity during rush hours. The heavy traffic surrounding the area limits views from the area. A new highway is in the city's plans, Sundabraut, and would be located at the northern fringe of the study area. This road's task will be to diffuse the traffic and ease the traffic on Artunsbrekka. However, some transport research has indicated that an increase in capacity leads to an increase in traffic.

The capacity of the street network is aggravated by its typology, so the problem can be addressed by improving connectedness. The aim should therefore be, instead of focusing on building new highways, to have good connections for other travel alternatives. By for example, having pedestrian and cycling bridges and tunnels to break up the connecting barriers that the highways are today. Within the area, the road Saevarshofdi disects the area and can possibly also act as a barrier. Furthermore, it might be developed in such a way so as to serve a throughway connecting Vesturlandsvegur and Gullinbru roads. The ERB Area has an opportunity to introduce a new travel option in Reykjavik, a ferry connecting the area to the City Center. By doing so, more travel altarnatives are being created. This new travel option should be implemented as a part of the city's public transport system, to encaurrage people to choose that travel option. The sailing distance is approximately 7 km (Figure 16), and could be ideal to connect the area, and possibly other areas too, such as Grafarvogur and the island Videy, to the city centre.

Figure 16: The blue line shows a possible route of a ferry, connecting the ERB Area (white frame), and nearby areas, to the city centre (red frame) (Google, 2011).

Newman and Kenworthy (1999) point out that the needs of motorists must be balanced with the needs of pedestrians and cyclists. They indicate that a reduction in speed limits and capacity will create choke points and reduce the impact of motor traffic. Therefore new interconnections should be considered to diffuse traffic from Saevarshofdi, and traffic calming measures should be implemented to improve the route for alternate modes of transportation including biking and walking. The streets of the whole area should be developed in a way to improve walking and biking. Building infill and retrofitting new houses up to the streets and moving parking from surface lots to streets and underground parking areas will turn streets into pedestrian-friendly places for multiple uses and modes of transportation (Jacobs, 1961). In turn, high quality public spaces, including streets and squares, increase optional and social acitvities in public places (Wheeler & Beatley, 2009). Providing more connections in the road network while implementing traffic calming measures will soften traffic on main roads and improve access and circulation (Newman & Kenworthy, 1999), while also diffusing traffic and pedestrian activity into surrounding local streets to improve social interaciton in these dead zones.

New bus routes should be planned in the area at a early planning stage to prevent residents to have to rely on the car. Techniques should be used to make the system more efficient, for example, by giving the busses priority in traffic.

Social Environment

Social issues are tied to the built environment and as such are addressed by some of the same issues mentioned above. The limited accessibility and poor opportunities for social interaction are due to the characteristics of current land use and transportation. These can be mitigated by improving accessibility and by reshaping the area to remove the barrier effects, as well as adding new connections. The area should be designed as a human scale built environment. The addition of mixed use buildings in the densification scheme will improve

social interaction and add a variety of built forms, making the environment more human scale and more lively during all hours of the day.

3.1.4 Current Plans for the ERB Area

The General Plan for Reykjavik forthcoming in the spring of 2012, emphasizes sustainable development in urban areas and transportation. The General Plan considers the ERB Area to have many opportunities for redevelopment if the comercial premises requiring a lot of land and the industry responsible for emissions is removed. The General Plan suggests instead a residential area with mixed uses. In more detail, the area should be developed into a diverse and densely built urban environment with good connections to nearby areas. The General Plan suggests a new area to take over the industries and commercial premises (Reykjavík 2030, 2011)

The General Plan divides the ERB Area into six smaller areas having different functions: Port related premises; Commercial premises; undeveloped open areas; Mixed uses; and a Center (Figure 17).

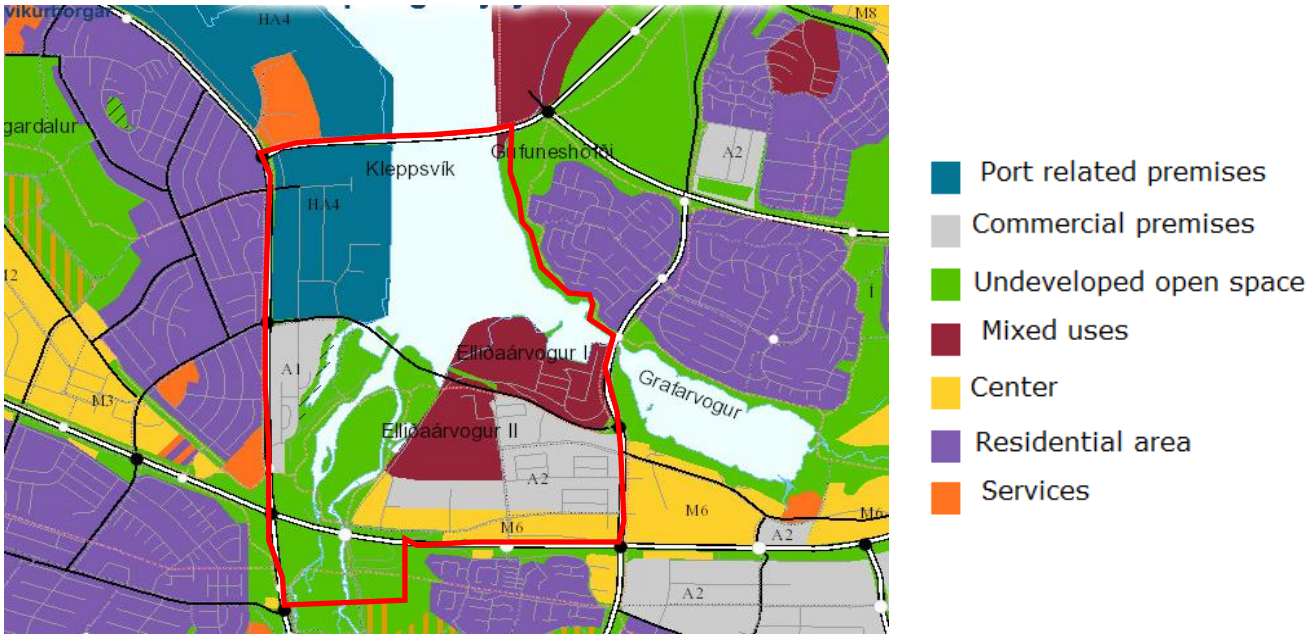

Figure 17: Reykjavik's General Plan proposal for the ERB Area, marked with a red frame, and nearby areas (Skipulagssjá, 2011).

Table 9 shows current facts about the ERB Area and the proposed new planning numbers for the area. Today the area is 239 ha in size, with only 340 residential units. The General Plan proposes that the area will have 3400 residential units by 2030. In 2009 work areas covered 330,000 m^2. The General Plan suggests this number should grow to 420,000 m^2 in 2030 (Skipulagssjá, 2011).

Table 9: Proposed development of study area as set forward in the General Plan for Reykjavik (Skipulagssjá, 2011).

1) Current size of study area (ha)

	Area
Open and undeveloped	40
Developed	179
Total	239

2)Existing and proposed residential units

	2011	2030
Sudarvogur	0	400
Bryggjuhverfi (Harbor Area)	340	800
Artunshofði	0	700
Midjan /center	0	400
Saevarshöfdi	0	1.100
Total	340	3400*

*) Estimated need for three primary schools and six kindergartens

3) Size of work areas in m2

	2009	2030+
Offices	16.500	180.000
Retail and service	16.500	180.000
Industry	110.000	0
Other use	187.000	60.000
Total	330.000	420.000

3.1.5 Strategy

Summary of analysis

- Water front developments can both be valuable and vulnerable;
- Densification is the politically mandated goal in Reykjavik's General Plan;
- The ERB Area is identified as a key area for densification, with a redevelopment creating mixed use neighborhoods;
- Use sustainability as a constraint to densification;
- The ERB Area's biggest qualities are the vivid and beautiful natural environment, with water fronts and mountain view;
- The ERB Area's biggest flaws are unattractive industries responsible for emissions and commercial premises requiring a lot of land placed in the area, and connection barriers;

- The ERB Area's current built environment provides plenty of opportunities for urban densification while partly taking advantage of existing transportation systems and urban infrastructure, at the same time as maintaining valuable open space.

The following principles have been developed from the earlier discussion in Chapter A. These will be applied to the issues that were identified in the analysis. The principles that should be used when densifying Reykjavik:

- Consider daylight conditions when densifying;
- Densify to take advantage of existing public transportation systems;
- Develop in existing urban areas at higher density to encourage sustainable modes of travel;
- Use already paved surface for development when possible;
- Compensate for reduced green space by developing remaining space, for example by planting trees or give buildings green roofs;
- Densify, while respecting the local environment, to improve the social and economic climate.

It is ideal to redevelop the ERB Area to densify the city, because the development will be in existing urban area which has plenty of paved surface and therefore ideal for retrofitting houses. It is important to consider daylight conditions when redeveloping the ERB Area and to compensate for lost green space. The following principles should be kept in mind when redeveloping the ERB Area:

- Use the most appropriate local energy source if possible;
- Design the energy system flexibly;
- Match buildings in terms of thermal needs;
- Choose the most appropriate energy technology;
- Place recycling facilities close to its sources;
- Consider location and connectivity to shorten trips;
- Connect neighborhoods with car-free routes;
- Provide strong linkages to public transport from the beginning of the development to prevent residents relying on their car from the first day;
- Design areas with open storm water systems, or SuDS;
- Give buildings green roofs;
- Include nature in the urban design;
- Involve stakeholders in the planning process.

The development should focus on the following issues:

- Space between buildings and separation of functions;
- Emitting industries and much land requiring commercial premises;
- Underused green space with low ecological value, in contrast to green corridors of high value;
- Connection barriers, such as the highways surrounding the area and natural barriers within the area;
- Built environment discouraging social interaction;
- Non-human scale of streetscape.

3.2 Marketing Measures

3.2.1 Target Groups

Since the economic crash in 2008 the unemployment rate has been high in Reykjavík and is still in January 2012 a big problem. At the same time the tourist industry has been increasing, as it is finally affordable to visit Iceland. This situation can be taken advantage of. By developing the ERB Area by focusing on the tourist industry, a possibility is offered to create businesses that attract tourists to the area, and in doing so creating job opportunities.

The aim of the plan is to develop the ERB Area in a way that attracts diverse groups to live there. That way a more social equity is established. The aim is to get people to choose to live more centrally in Reykjavík than on the city's edge in the sprawling suburbs. By choosing the ERB Area to live in, people will have to live more closely with their neighbors in a dense urban district. This might be hard to sell to people wanting the calm suburban lifestyle. But it can be a success, by having a high quality attractive urban design in a beautiful environment close to the sea and nature. The earlier mentioned sustainability projects in Sweden, the Western Harbor and Hammarby Sjöstad, are examples of similar developments that have become extremely popular places for people to work, live and play, as well as visit, thanks to the high quality urban environment in the areas and closeness to sea and nature (Figure 18).

Figure 18: Residents and visidors enjoying the sea site on a sunny day at the Western Harbor in Malmo. The access to the shore line is open for everyone to enjoy, and the urban form is rather compact (O'Hare, 2009).

3.2.2 Promotional Marketing Measures

Places can benefit from their singular identity and can be known for their identity, for example if a place has a desirable attribute such as heritage, nostalgia or natural beauty. The ERB Area is known as an industrial site and can benefit from its industrial heritage. The industrial heritage should be kept as a part of the identity of the area. When redeveloping the ERB Area, some of the industrial characteristics of the area should be kept. Closeness to the elements of nature such as the Ellida River, the Ellida River Valley and the shore line promotes the area. It is not common to have a district like this, filled with natural beauty and closeness to nature, centrally located within an urban area. By making the area filled with fun activities, and designing it in a charming way, the area can be developed into a popular living area as well as a popular place to visit.

3.2.3 Organizational Marketing Measures

The ERB Area should be developed to be charming for tourists and Icelanders by providing different activities and high urban quality. There can be many different ideas about how to make this happen. A good way to explore different ideas is through a large scale planning contest, within the framework of sustainable urban design guidelines. Besides taking hold of

a wide range of ideas, the contest will also promote the area by creating positive attention. This is a good way to include different stakeholders in the planning process, by including firms, the general public and other stakeholders in the development. One possible problem in developing the ERB Area is that there is a diverse group of stakeholders in the area, and it can be a problem to find a new place for the industries and commercial premises that should leave the area for the development to become a reality. It can be a big challenge to make these landowners and other stakeholders agree to development and densification. By including them in the planning process they may well accept the development more easily.

3.2.4 Spatial Marketing Measures

The ERB Area has great opportunities to become an attractive place. The natural environment and location are probably the area's two biggest strengths. The non-emitting industries should be kept and the ones that do not require much land mixed with commercial, offices and residential houses. The residential houses should be varied in looks and sizes to attract various people of different ages and income levels. By transforming some of the empty former industrial buildings into residential, office or commercial houses the industrial characteristics of the area will be preserved and the place will become unique. There are a lot of parking lots and unused spaces between buildings which should be used for densification. There are great opportunities for diverse activities to take place in the area, with a lot of space: the Ellida River, the shore line, and the steep slopes. These assets should be used for entertaining, healthy and attractive activities for everyone to enjoy. The activities will make the area alive and enjoyable for residents and visitors. The streets of the area should be pedestrian friendly with no heavy car traffic. Pedestrian and bike paths along with bus routes should therefore be well organized

3.3 A Plan Proposal for the ERB Area

The aim of the proposed plan for the ERB Area is to respond to the identified most urgent local issues: the city's high car dependency and the resulting threats to human health. The plan proposal also responds to the most important global challenges: climate change and dependence on unsustainable and expensive sources of energy. The ERB Area should be developed to meet all three aspects of sustainability: Stand for a combination of Economic Efficiency, Environmental Protection and Social Justice.

The main planning principles identified in Chapter A were used when developing the Regional, General and Detail Plans in a sustainable way. By developing the area by aiming for high density, localism and mixed functions, the central goal is to shorten travel distances. By doing so, walking and bicycling can be looked on as real travel options and the public transport system more efficient. With this development diverse transport options will be offered to residents and Reykjavik will become less car dependent. Residents will become healthier with increased walking and cycling. Good connections within the area and to nearby areas are the key for this development to be a success. Open green spaces with high ecological value should be preserved, and it is important to compensate for lost green space to keep the area's biodiversity. To ensure the sustainability of the individual, well designed public places are needed for restoration.

The next section presents guidelines for the urban design for the area, as well as a proposal for possible plans. It is important though, to include all stakeholders early in the planning stage

of the area to get all the knowledge about the area and to hear all voices. That way the planners get important information and a better approval from stakeholders of the development. The next section is only an attempt to show how the area could be developed guided by the proposed planning principles in Chapter A, but there are of course many ways of using those principles and developing the area in an interesting way. Marketing measures are also used because it is important to consider who will live in the area and how to attract people to choose to visit and live in the area.

3.3.1 Urban Design Guidelines

Regional Plan Scale

The Regional Plan proposal for the ERB Area focuses on good connections to the project area and from the project area to other parts of the city. The ERB Area is considered to be fairly well connected with the existing road system, so the Region Plan proposal focuses on green connections, having car-free routes across the city. This planning principle was identified in Chapter A as one of the key emphases by CABE. With the car-free routes, the benefits will be in reduced greenhouse gas emissions, a more affordable travel option than the car is, and a better health of citizens in general. The ERB Area has great potential to have good green connections to all parts of the city, with little or no further constructions. The Ellida River Valley is already mostly a car free route connecting the area to the south, green connections run to the west are through Laugardalur and Fossvogsdalur, with a little construction work the routes can be designed to be car free, as well as connections through Grafarvogur east and northeast of the Area.

The Regional Plan proposal aims to show that the city has bicycling friendly distances. Bicycling can be a real travel option in Reykjavik with a well-designed path system. The circles show the bicycling distances within and out of the city, in bicycling minutes and distances in meter, with the starting point as the project area's geographical point (Figure 19). The circles were designed using Reykjavik's Bicycling catalogue (Reykjavíkurborg, 2010, p. 29). The main purpose is to give an idea of how bicycling can be done easily. The bicycling minutes cannot be estimated exactly because they vary with the individual. The most visited places are marked on the map as well, so it is easy to realize how much time it would approximately take to bicycle from the study area to the most visited places in the city.

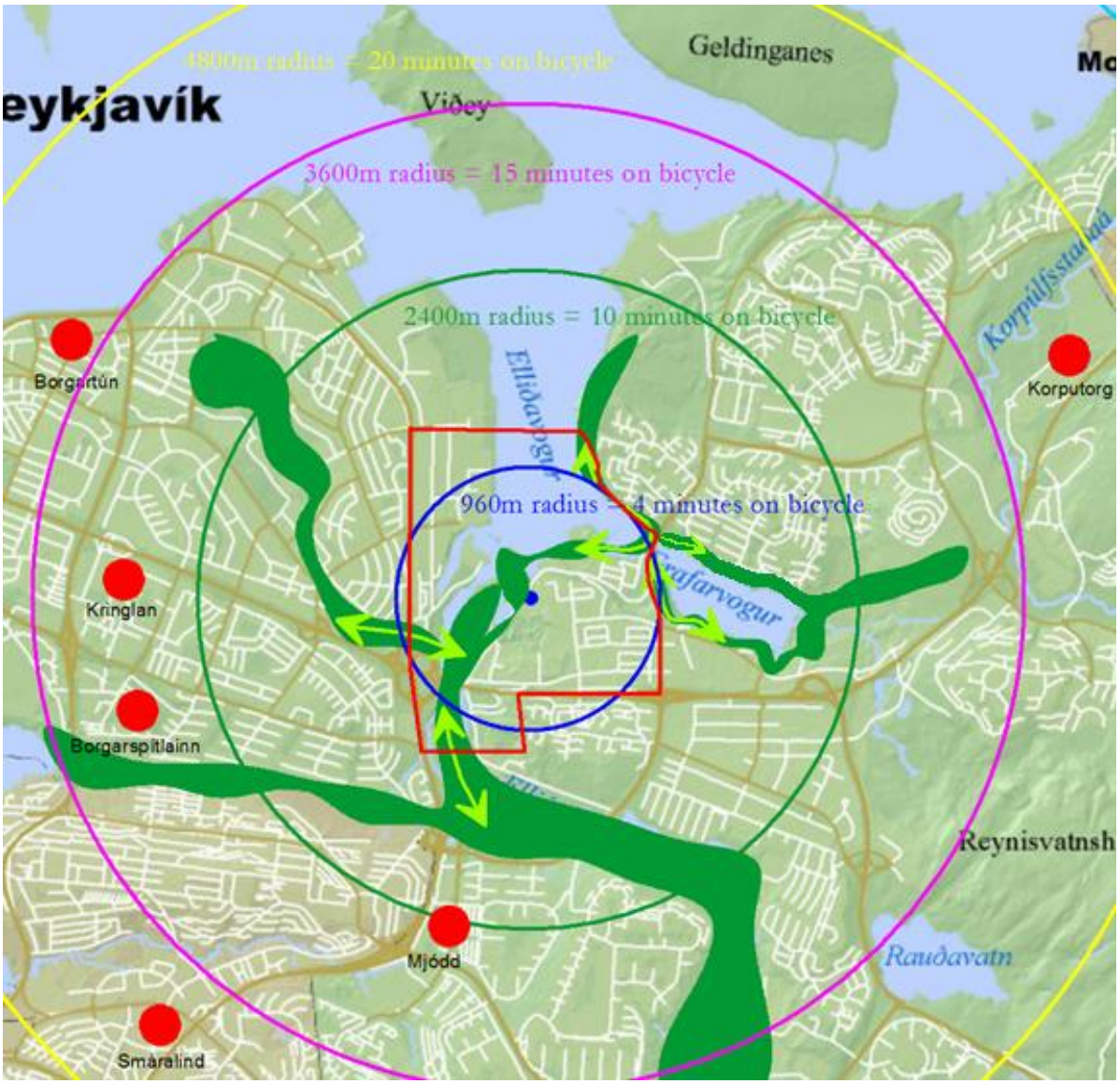

Figure 19: This section from a Regional Plan figure shows how easy it is to get around by using a bicycle in Reykjavík, which is both a healthy and sustainable life-style option. The red box shows the planning area. The red dots show important places and the green axes show green connections to and out of our planning area, which have great potential to be car free routes. The blue dot in the middle of the planning area is the area's geographical middle (Reykjavíkurborg, 2011). A bigger figure showing the Regional Plan section for the whole city, can be found in Appendix A.

General Plan Scale

The main focus of the General Plan is to plan the area with as mixed functions as possible and to provide good connections. The road and path systems are designed to make sustainable travel options the most appealing option to get around in the area. Recycling facilities should be close to every home and office. Places where people are able to grow their own food are positioned in every neighborhood. Energy should come from local renewable sources, and policies should be implemented to make the use of the energy as efficient as possible. With the proposed plan, the aim is to steer the residents to choose a healthy lifestyle.

Landfills with waterways and canals are proposed which will make the area more diverse and charming. The localism principle should be used when making the landfills. That can be achieved by using local material for the landfill and the construction of the canals which is available within the area. As Valsson (2000) argues, nature should be included in the urban design, and contrasts should be regarded as concurrent units. With the canals the aim is to put a small core of the ocean into the land, and the landfills have the same purpose for the ocean. Emphases are put on having water sports and activities to connect the urban environment to the shore line. In this way the urban design of the place will become more interesting and a balance made between the ocean and the land.

The area is divided into six neighborhoods (Figure 20), and should offer various types of houses to attract various groups of people to live in the area. The suggested names of the neighborhoods work both in English and Icelandic. The density of the whole area should be no less than 30 inhabitants per hectare, with each residential unit to have 2.2-2.4 residents (Axelsson, 2011). For the sustainability themes to work out, this high density number is at least needed. The density rates of the current General Plan for the area is little over this number, which is why new numbers are not suggested, but the area has a potential to be developed with higher density than what the General Plan suggests.

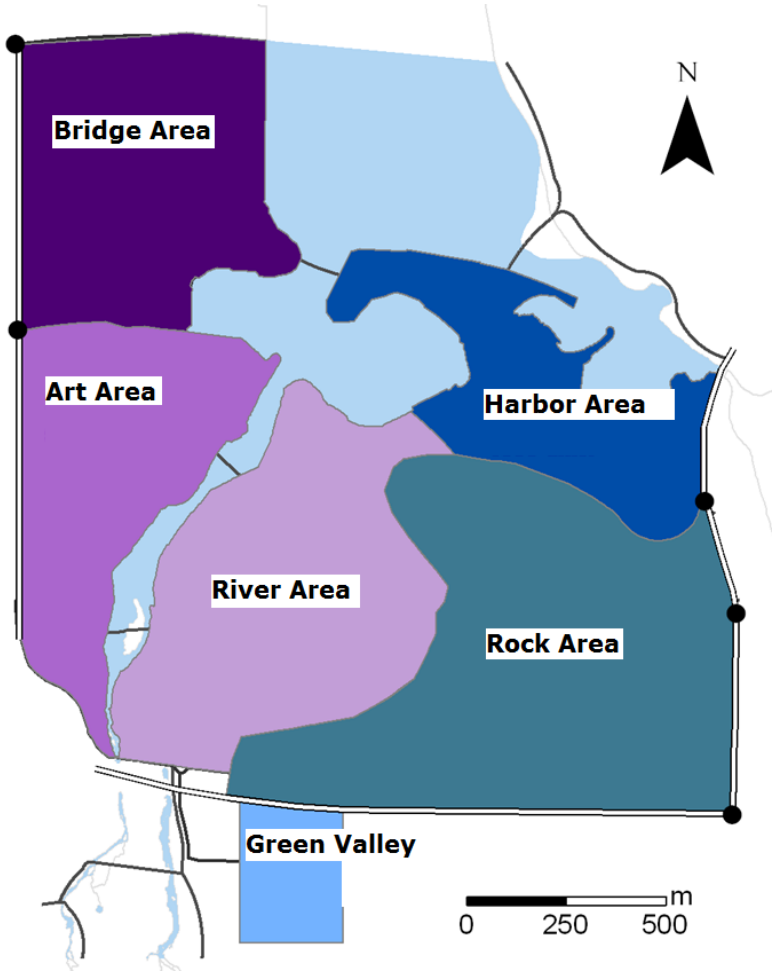

Figure 20: The six suggested neighborhoods in the ERB Area.

Harbor Area (Icelandic, Bryggjuhverfi) already exists as a residential neighborhood in the area with 300 residential units. The suggested General Plan proposal is to enlarge the Harbor Area, for example by using landfill, up to at least 800 residential units. The Harbor Area's main characteristic is the marina. This plan proposal suggests another marina facing more to the south. The marinas give a unique charm to the area. The landfill facing south would be a beach. *Healthy activities:* Water sports such as small boats, canoes, kayaks, jet skis, pedal boats and ocean swimming.

River Area (Icelandic, Árhverfi) has 1100 residential units, according to the General Plan proposal. The neighborhood has the Ellida River running through it and a shore line. The neighborhood faces southwest and has a natural wind shelter from the steep slopes. It is the most central neighborhood in the area. These facts make the River Area ideal to be developed as the core of the project area. *Healthy activities:* The activity paradise in *Geirsnef* having mini golf, playground and fishing, the *Lazy Town Museum* later introduced is located in this neighborhood as well.

Rock Area (Icelandic, Klettahverfi) has 700 residential units, according to the General Plan proposal. It is the biggest neighborhood in km^2. The area's position is on a cliff with a great ocean and mountainview to the north. *Healthy activities:* Outdoor training equipment and winter sports on the slope.

Art Area (Icelandic, Listahverfi) has 400 residential units, according to the General Plan proposal. Today many artists have been using former industrial buildings for their work because of the low rental price and a music school is located there. This proposal suggests keeping the artists in the neighborhood, and using art to make the neighborhood unique and charming. *Healthy activities:* Skateboarding park, outside art, a dog park and a marina offering water sports.

Bridge Area (Icelandic, Brúarhverfi) has no number of residential units in the General plan's proposal, but should be capable of having 1000 residential units. The area is unique because of the canals on the east shore line. *Healthy activities:* Outdoor training equipment and water activities.

Green Valley (Icelandic, Græni Dalur) has no number of residential units in the General plan's proposal. The area is located in the Ellida River Valley, one of the recreational pearls in Reykjavík, with the Ellida River running through it. *Healthy activities:* Fishing, horseback riding and skiing.

The main development progress takes into consideration the existing landscape contours and buildings. Geographically the area is divided into three parts, which can be developed at the same time if necessary. The neighborhood *Green Valley* needs no concrete development as it should mainly be used for outdoor activities but not for new constructions.

The development of the area is illustrated in figure 21. The first development phase is the expansion of already existing residential areas, i.e. the Harbor Area and also the Art Area. From there the expansion should be towards the geographical center.

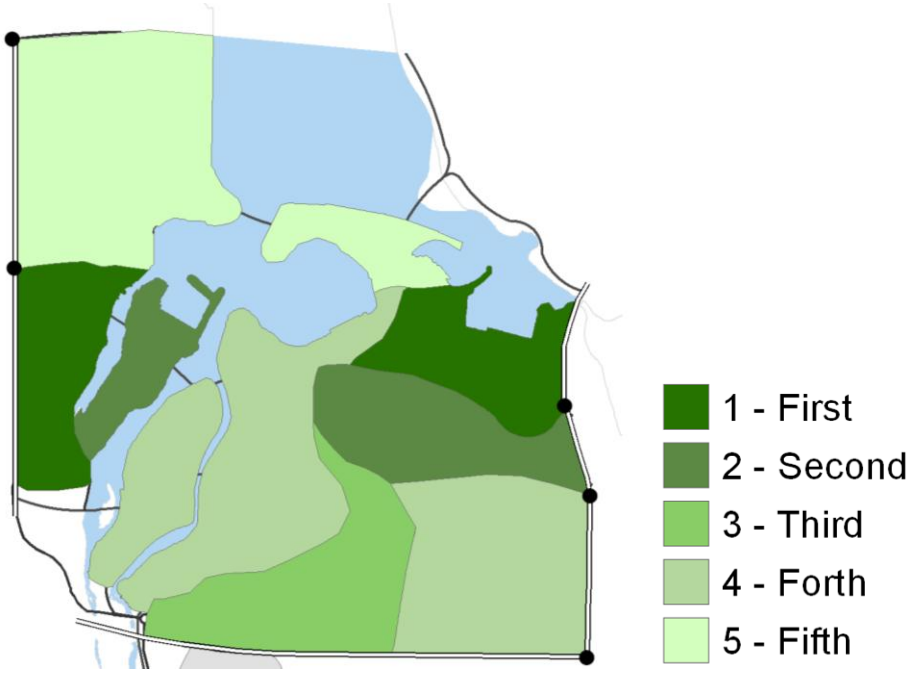

Figure 21: The development progress of the project area.

Office buildings are positioned along most of the primary and secondary traffic roads (Figure 22). That way they are well accessible and create a shelter from air and noise pollution. Commercial buildings are placed in the sunny River Area, with well-designed public spaces. *Geirsnef* in the River Area is a landfill, and should both have well designed open space and various activities and facilities related to them. Therefore it is decided to develop *Geirsnef* as an activity paradise that will attract tourists and visitors from all around Reykjavík and abroad. With the attractive activities the aim is also to connect the western and eastern parts of the study area. Four schools are suggested in the plan proposal, two have 1st to 7th grades, located in the Bridge Area and the Harbor Area. The third one will be located in the Rock Area with 1st-10th grades. The fourth suggested school is an Art School located in the Art Area. A sport center will be placed inside the Rock Area's cliff, with an outdoor sport field on top of it. The *Lazy Town Museum* will be the area's flagship, positioned in the River Area, with a great view of the ocean and the mountains.

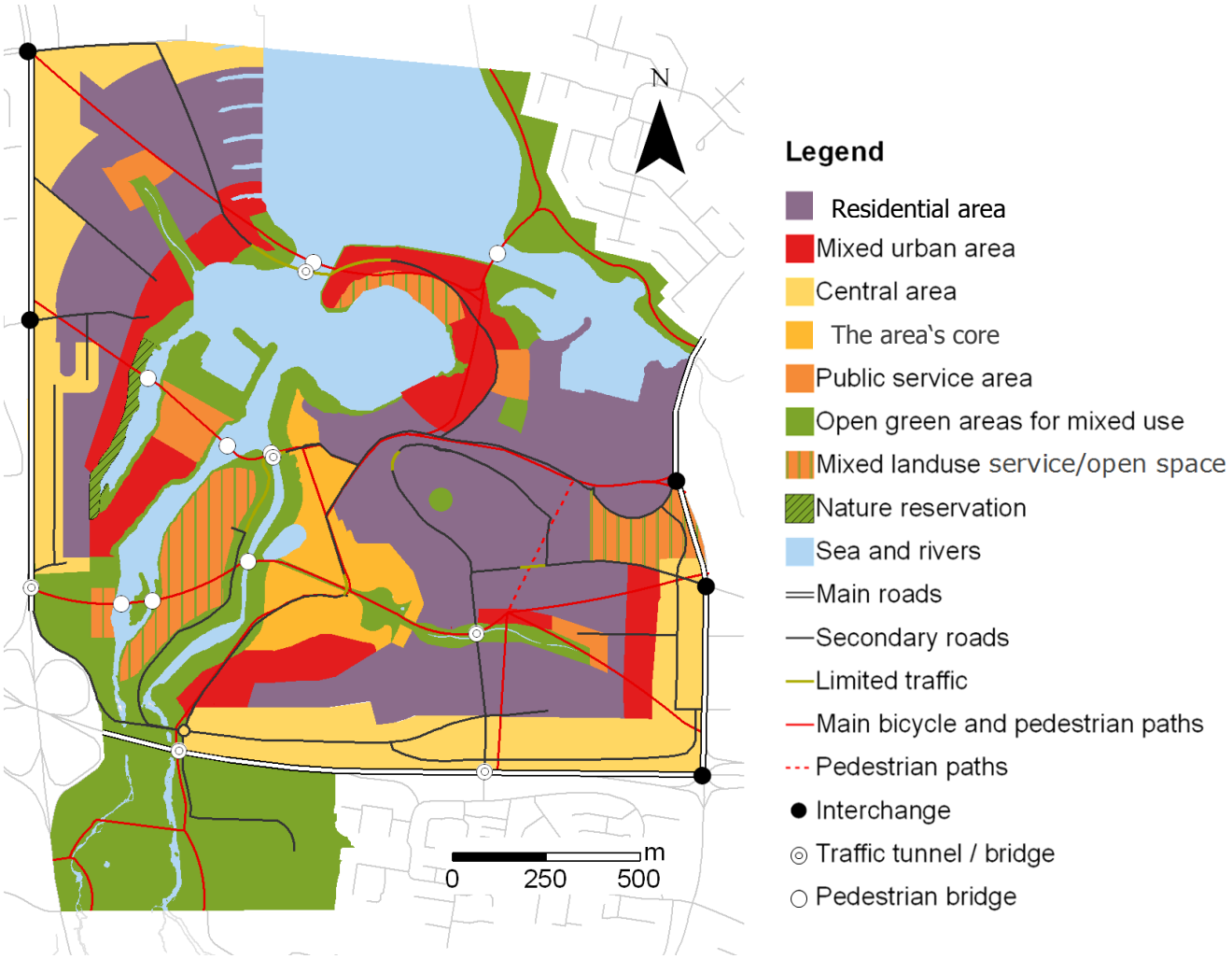

Figure 22: Proposed General Plan for the ERB Area.

According to Pall Lindal's (2011) unpublished lecture, the importance of considering the sustainability of the individual is not less important than the other aspects of sustainability. In his lecture he explains the necessity of well-designed places for psychological restoration. Research shows that it is about 80% certain that a person visits a public place daily if it is well designed and within 300 meters of the person's home. That is the reason why this plan proposes a well-designed open public place within every 300 meters from every home. A green axis is placed in Rock Area, with a visual axis to *Geirsnef*. The green axis has outdoor training equipment for people to exercise. A similar axis is located in the Bridge Area. The green axes are car free routes, connecting the neighborhoods within the ERB Area. All the neighborhoods should be designed to have open storm water systems. An open storm water system increases the area's biodiversity and gives the place a special charm.

Most of the area's shore lines are undeveloped or have activity-related facilities. The purpose of keeping the shore line open and little developed is to be prepared for sea level rise and to ensure everyone access to the shore line. To compensate for lost green space, some buildings have green roofs. Most of the green space in the Ellida River Valley is preserved.

Emphasis is put on encouraging residents to look at bicycling as a real travel option. Bicycling has no greenhouse gas emissions; contributes to better health of residents; and

requires less space than cars (Figure 23a). Pedestrians and bicyclers have priority in the area (Figure 23b), with well-designed paths and good connections to and within the area through green axes (Figure 24). The paths are separated and well marked. To encourage bicycling the bicycling facilities are well designed (Figure 23c). A bicycling rental system is available for everyone to use, with electric bikes as well as regular ones (Figure 24).

a ***b*** ***c***

Figure 23: a: The figure shows how eight parked bicycles require the same space as one car (Zimmer, 2011). b: Bicyclers are given priority by being able to be first in line at a red light (Reykjavíkurborg, 2010, p. 41). c: Area offers specially designed for bicycling facilities, for example bicycle parking lots sheltered from the weather (Shono Architects, 2006).

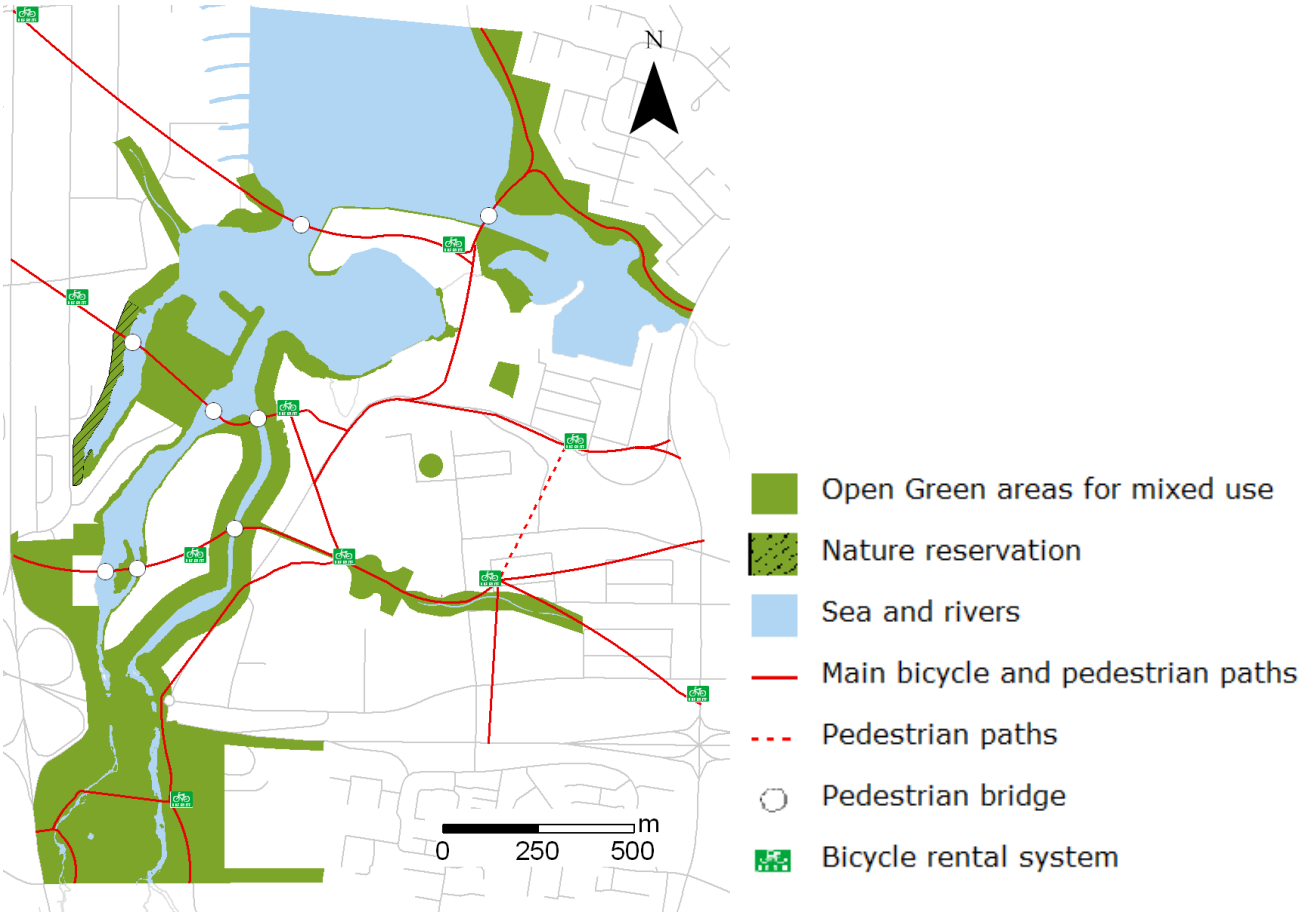

Figure 24: Open green areas are located within every 300 meters from each home of the area. Bicycling and pedestrian paths area designed in a way to make travel distances short and easy to travel. The figure shows also a bicycling rental system proposal.

There are good road connections to the area. The road system within the area is designed in a way to make use of some of the existing road network, and to prevent through traffic and to make bicycling, walking and public transport the most comfortable and fastest travel options (Figure 24 and 25).

The secondary road system has good connections to the primary roads surrounding the area, to make the area well connected to other parts of the city. Within the area the roads all have a dead end to prevent short car trips within the area and to lessen the area's car traffic in general. The secondary roads are open for public transport and security cars, such as police cars and ambulances, to drive through. Smaller underground parking lots are in many places of the area.

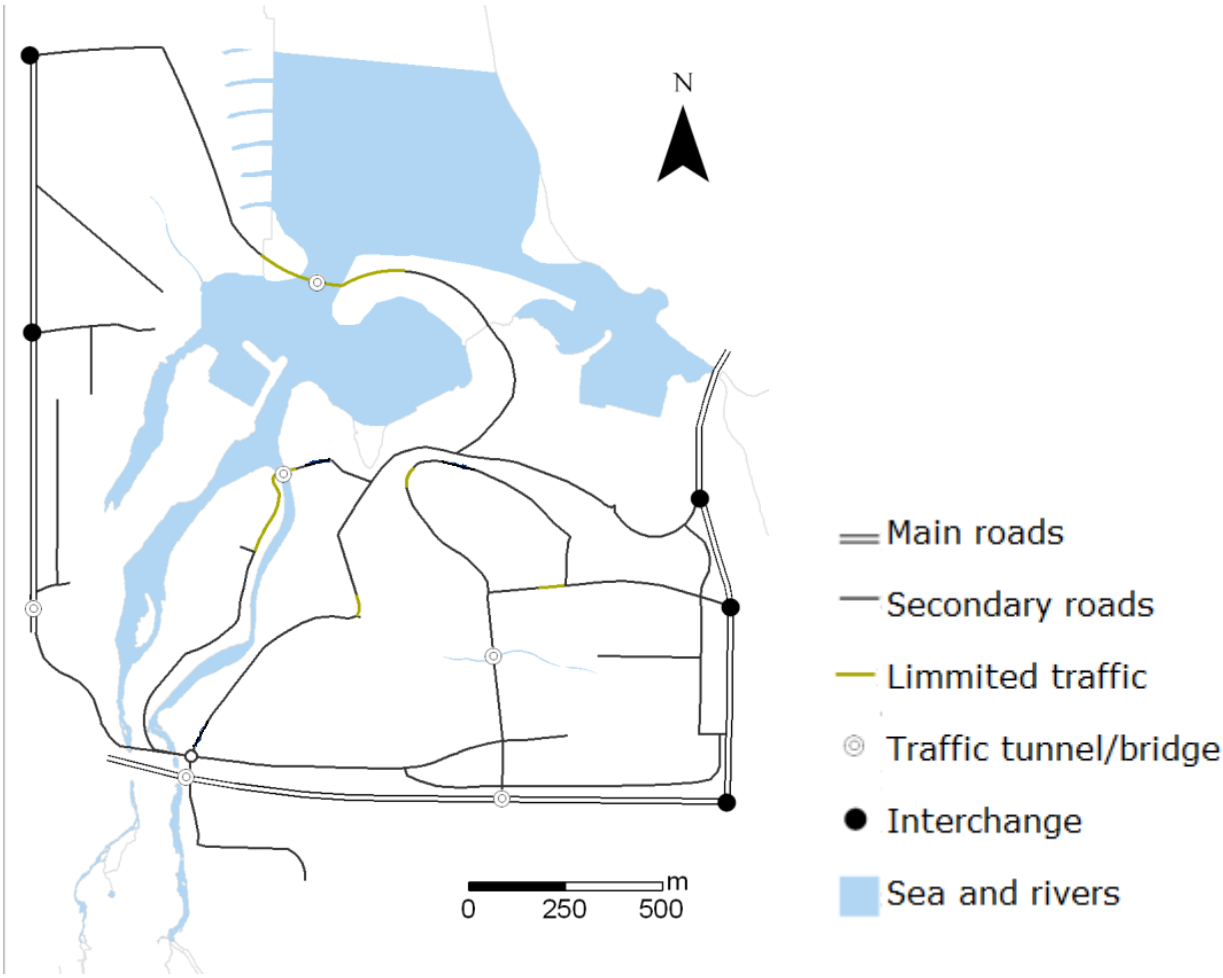

Figure 25:The Road system.

Detail Plan Scale

The Detail Plan covers a big part of the River Area and a small part of the Rock Area (Figure 26). The plan proposal shows how the houses are positioned, the housing types, sizes, and shapes. An idea of the area's compactness is shown (Figure 26 - 27). The shore lines are preserved and open for everyone to enjoy. The plan explains the path and road system in more detail.

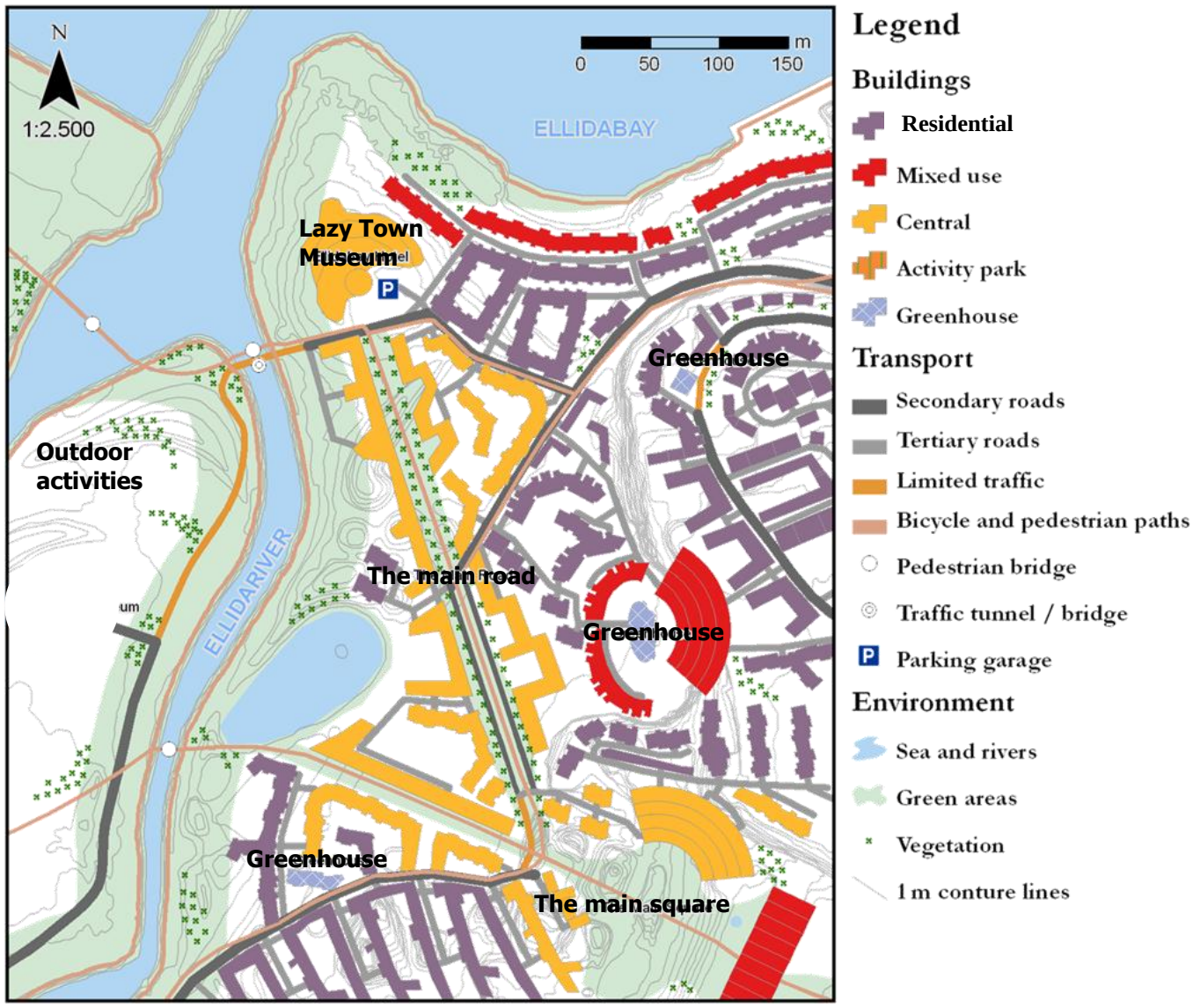

Figure 26: The Proposed Detail Plan.

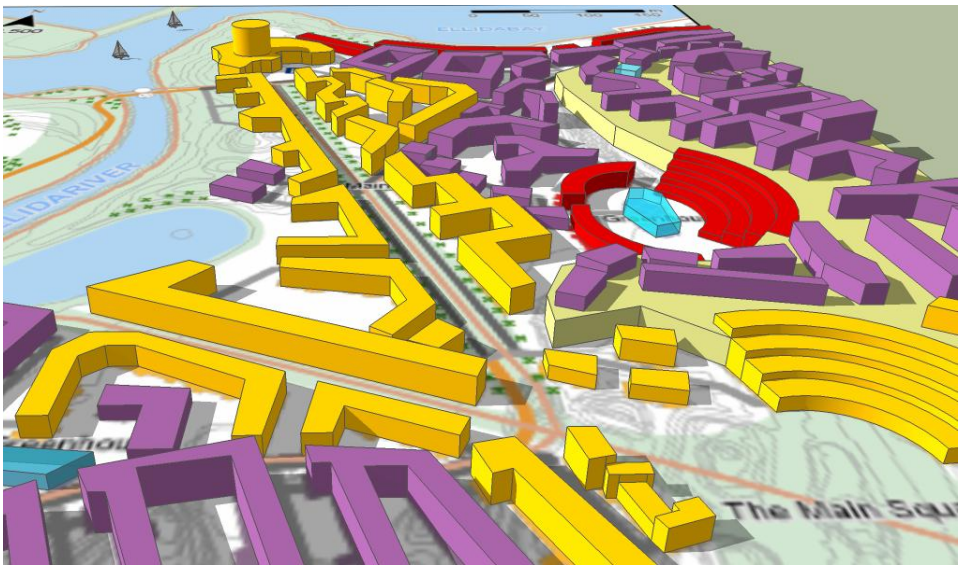

Figure 27: A bird's view of the Detail Plan proposal. Purple: Residential area; Yellow: Central area; Red: Mixed use; Glass: Greenhouse.

The green axis in the Rock Area is connected to the main square in the River Area. The green axis has a small river running through which collects rain water and ends in a pond located on the hill just above the main square. The fountain located in the main square is powered by the falling water from the pond (Figure 28). This shows one of the sustainable solutions in the planning proposal.

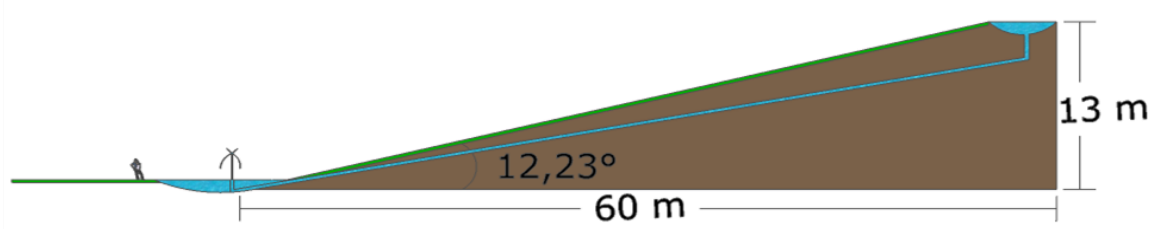

Figure 28: A cross section showing how the fountain is powered by sustainable energy, i.e. the gravity of surface water stored above.

The main square is surrounded with buildings with a mixture of commercial and residential functions. The square attracts people with a flea market (reuse of things), a farmers' market (local food production), and other activities (Figure 29). The barracks on the hill above the square already exist (Figure 8bd) but have been transformed and have new functions. With this kind of action, the characteristics of the area are kept. The barracks impart a special and unique look to the area. It is considered to be more sustainable to transform already existing buildings into new functions instead of tearing them down and building new ones. Evaluation of the shape of the buildings must be done, however, before determining whether to transform them or tear them down, because some buildings are in such bad shape that it is a better option to tear them down and build new ones. It is questioned if the barracks are in such as shape to possibly transform them, but if not, buildings in similar shape could be ideal to build there, as a reminder of the barracks. The green axis from the Rock Area continues through the square to the activity park in *Geirsnef*. No cars are allowed in the green axis.

Figure 29: The main square should be filled with life every day. Its attractive functions and urban design, facing south and sheltered from the wind, will contribute to its desirability.

The road and path system is partly explained in Figure 30. The systems are separated to make them secure and easy to use. The main road has all three travel systems.

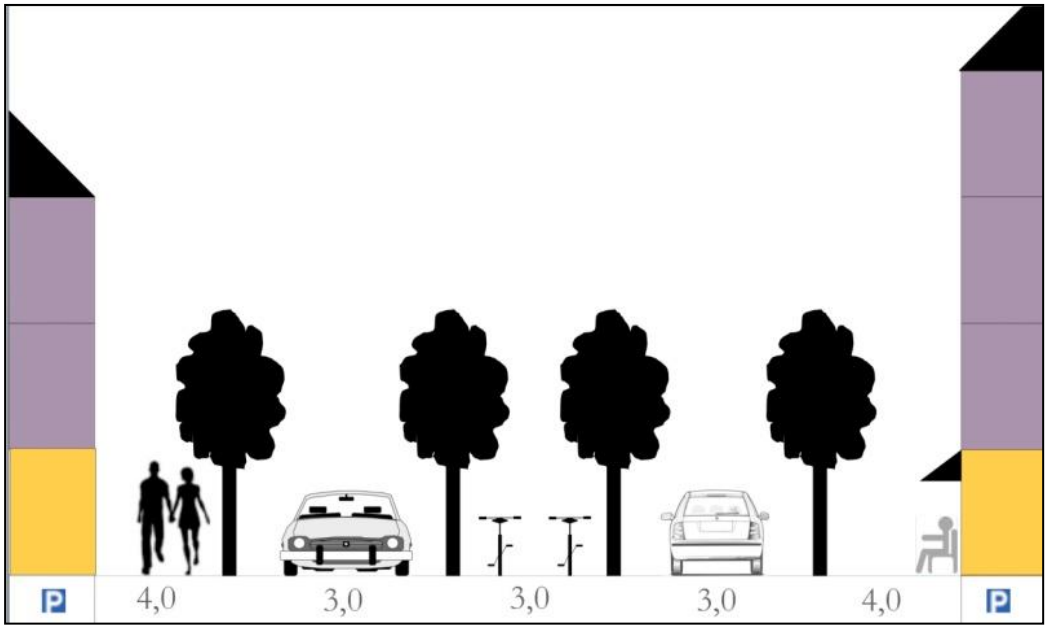

Figure 30: This cross section of the main road shows how the travel systems are separated, as well as how commercial buildings are mixed with residential units. Yellow represents commercial functions and purple residential units. The buildings have underground parking spaces.

A museum is suggested in this plan proposal based on the children's show Lazy Town. Lazy Town was invented in Iceland and is an informative children's show about a healthy lifestyle, the importance of exercising and eating healthy food. Inside of the museum are children's sized models of the show's town, with all the houses to play in, as well as a theatre with plays from the show. The theatre is also an information center about health and sustainability in the ERB Area. A greenhouse with local food production and a restaurant offering healthy and locally grown food are also suggested to be in the museum. Outside are also other activities contributing to the museum visitor's health.

The purpose of the suggested Lazy Town Museum is to attract one of the already identified target groups, tourists. With this attraction, the aim is to make the ERB Area have visitors and be a lively site. Other possible tourist attractions are perhaps to include a horse rental, since the Icelandic horse is one of the country's main tourist attractions. The area is connected to the country side through the Ellida River Valley, which already has a horse track going through. Therefore having a horse rental in the area could be ideal for attracting visitors.

3.4 Discussion and Conclusions

3.4.1 Stakeholder Engagement

The consideration of a number of different stakeholders is involved in realizing this plan. Even though densification is a goal in Reykjavik's General Plan proposal, implementing it is not a one-way process without conflicting opinions. The current role of the planner is as much about coordinating interactions between different stakeholders as designing actual plan documents. Reykjavik carries the main responsibility for new plans. However, these visions cannot be attained without a wide range of horizontal interaction and cooperation with stakeholders such as financiers, real estate developers, building companies, landlords, and community representatives including residents and local businesses and others. The plans also have to satisfy the political agenda as well as the opinions and needs of citizens and other stakeholders. This requires not only professionally designed plans but also a democratic planning process based on an open dialog between those involved.

A good way to resolve possible conflicts when redeveloping the ERB Area is by using Forester's (2006) approach of conflict solving. The approach says that- with the focus of co-working instead of playing the role of being against each other, conflicts can be resolved. The trick is to have transparent and assessable information for the stakeholders. By getting them informed they will become more open minded and have a better understanding of each other's issues and concerns.

The planning processes of Iceland are quite clear about the importance of stakeholder involvement, and emphasizes including them early in the process. By including the stakeholders early in the planning process, it is easier to develop the plan to please different stakeholders. The comments made on the plan proposal should be taken into consideration and responded to.

Connelly & Richardson (2004) identify exclusion of people as one of the possible problems of collaborative planning processes because of how difficult it can be to establish ideal stakeholder involvement. Rydin (2007) writes about how important it is for the planners to hear all voices to get all possible knowledge in order to reach the best conclusion. The knowledge the residents of the ERB Area have can be important for the planners to have. The aim of the planning processes in the ERB Area is to create a proper community with residents mixed with commercial functions.

According to Watson (2003) the way to create a proper community is by using decision-making processes, involving people and stakeholders that the decision affects. To please all the stakeholders of the ERB Area it is important that they participate in the planning process. Planners are responsible for this to be a success and should use tools such as open houses for the collaborative planning process to be a success.

3.4.2 Limitations

There are limitations to the above proposal in terms of scope and possibilities of realization. The following are some considerations that must be taken into account:

- Ensuring that mixed uses materialize;
- Stakeholders will interpret the plan, i.e. negotiate the interior configuration of apartments;
- Notions of sustainability drawn from current European best practices for urban planning, but this is not a radical vision. Some elements may have a greater impact on sustainability than this plan can influence which pertain to individual behaviors and expectations:
    - Flat sizes and facilities;
    - Urban gardening;
    - Reduced consumption;
    - Issues of environmental justice;
    - Air travel.
- The types of housing that can be built are limited by market forces and lack of government subsidies for low income housing. Though a variety of housing is desirable, it highly depends on stakeholder cooperation.

The ERB Area can be developed into a sustainable living area with an interesting mixture of the natural environment and buildings, benefitting from its closeness to the sea. The development needs to fallow sustainable planning principles in order to make the area a success, and to become resilient to climate change. Examples of sustainable development in nearby cities show that it can be done. The need for planning urban areas in a sustainable way is clear. One question that comes up to mind when thinking about the redevelopment of the ERB Area is where the current functions of the area, that need to be removed, such as the land requiring and polluting industries, should be located? This needs to be thought about before redeveloping the area.

The former development of Reykjavik, that has primarily focused on the private automobile, needs to be changed. Researchers in Malmö proclaim that everywhere is in bicycling distance within this big city- so the same should hold true for the smaller Reykjavik. Because of the small size of Reykjavík the city has great potential to become less car dependent, with citizens relying on alternative travel options such as bikes, walking and public transport. The best way to contribute to less car dependency is to develop Reykjavík with the aim of making the city denser, which is already a set goal of the present plan. The benefits of developing urban areas with high density are many, as pointed out in this thesis. How and where this development is done, does matter in order for the development to be sustainable. When redeveloping such a big area as the ERB Area is, the development needs to consider more things than dense development, such as how to handle the six sustainability priorities identified by CABE: energy, water, waste, transport, green infrastructure and public space. Planners can play their role in developing

the city towards less car use, but the hard task at hand is to make people change their behavior and lifestyle habits, and it is questioned if it is possible to do so through the urban design of places? This question will be left unanswered, but it is the belief of the thesis' author that people will not change their behavior unless they have both the opportunity and will to do so. To inform people about the importance of this development can also help. What planners can do, and has been shown in this thesis, is to offer urban design with the option of living a more sustainable lifestyle. There should nothing stand in the way, of developing our cities with the aim of offering a sustainable lifestyle option, and give those who want to, a chance to change their lifestyle pattern, because those who will not, will also benefit.

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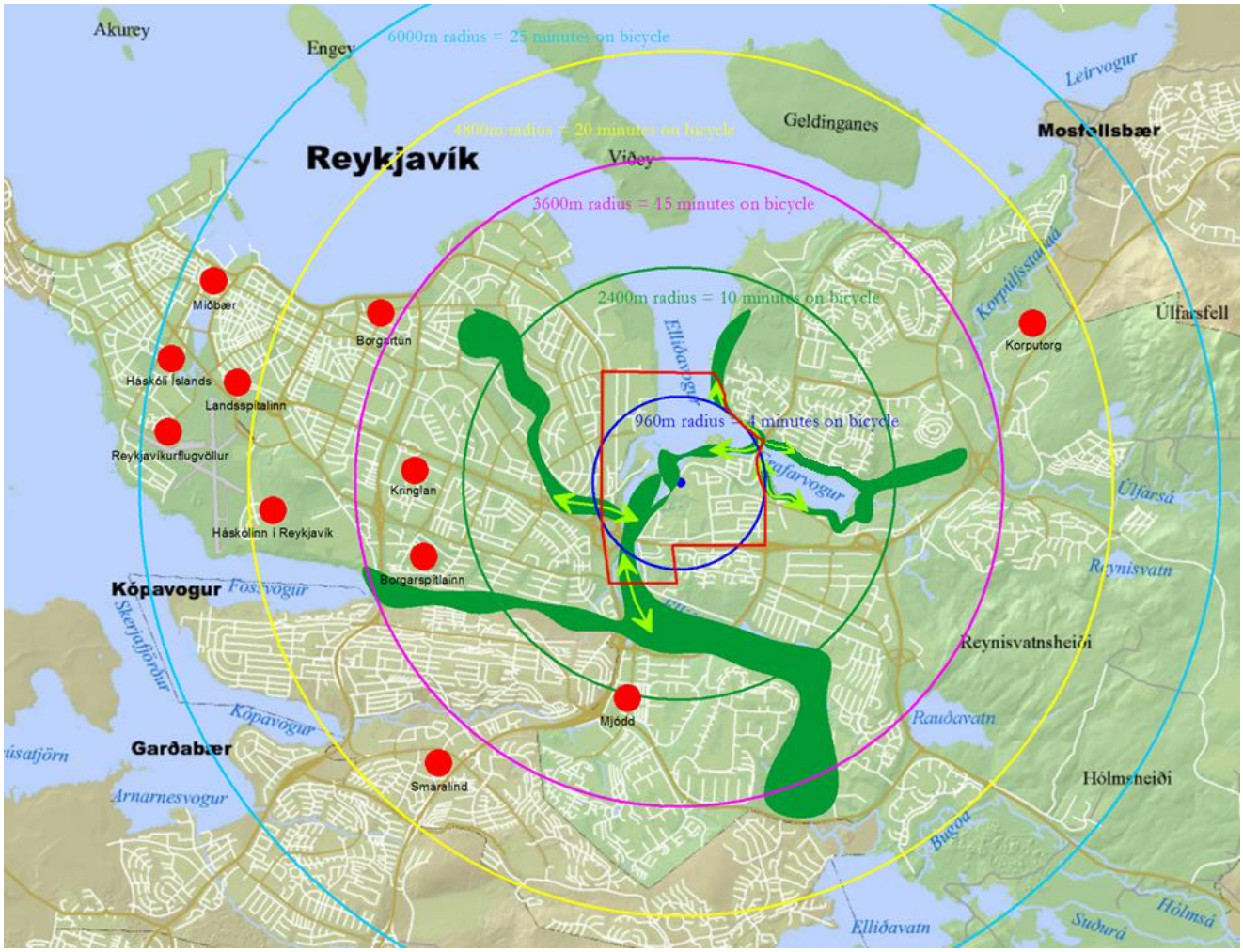
Appendix A

The Regional Plan level proposal for the whole city.



Appendix B

The concept of sustainability is becoming increasingly important in urban planning and design. In Iceland obesity has been a growing problem over the past years, which among other, might be a direct result of Iceland's high car ownership. Today's unsustainable development of Reykjavik makes it almost impossible to commute in other ways than using the privately owned car. It is urgent to change this unhealthy and unsustainable development. The planning idea also focuses on responding to the threats of climate change, by redeveloping Ellida Bay Area using sustainability as a constraint.

Basic Idea: Our planning vision of the *Ellida Bay Area* is a dense sustainable urban area, offering diverse, healthy and fun inspiring activities. The focus is set on localism, with well-designed places and mixed-uses, where people are able to live, work, study and play in the same locality. The plan facilitates recycling for inhabitants as well as companies and local services. People will be able to grow their own food and access healthy products in local markets. This design meets the three aspects of sustainability; Environmental Protection, Social Justice and Economic Efficiency, which together with various planning measures, contribute to a healthy lifestyle. With the suggested design of the area, the need for the privately owned car is minimized. The commuting distances are dramatically shortened with this planning pattern, making the area ideal for biking and walking. The benefits of such a design are enormous. To mention a few; the global environment benefits with decreased greenhouse gas emissions, the inhabitants profit extensively by being able to get around without owning a car, social justice is increased as residents are able to rely more on their local resources and community. With the decreased car use and more walking and biking, the residents will become healthier. Our plan aims to maximize the health factor by offering a multitude of healthy activities for residents and visitors to enjoy.

Transportation: The area is designed in a way that makes public transport, walking and biking the easiest and fastest way to get around. Car access to the area is from three of the main traffic roads of Reykjavík. The area's road system is designed to decrease through-going traffic and the use of the private car for short distances within the area.

Land-use: The area offers diverse land-use with emphasis on dense residential areas mixed with services, offices and other working places. Office buildings are positioned along primary- and secondary traffic roads and are therefore easily accessible. That way they create a shelter from air- and noise pollution for the residential areas. Commercial buildings are placed in the centre of the project area with carefully designed public places.

A sense of place: The Detail Plan shows the geographical centre of the planning area. This central area consists of human scale built environment with various architectural styles in both size and shape. An open storm-water system, with open canals and fountains, gives a unique charm to the area and increases biodiversity. Most buildings will have either green roofs or solar panels. The green roofs are energy saving because they work as isolation and they also increase biodiversity. The shoreline along the Ellida River is preserved for its natural eco-system and cultural value. *Geirsnef* is transformed to an activity paradise, including the *Lazy Town Museum*, attracting tourists and visitors from all around Reykjavík.

We are certain that the planning proposal ensures future generations a bright future.

Center of Sustainable Living

Healthy Living - Bright Future

Planning Concept

GLOBAL Sustainability Issues: Global Warming
LOCAL Sustainability Issues:
High Car Ownership and Health

Our Future?

Ideal Sustainable City Models in Sweden

Planning Principles

The suggested principals contribute to localism.

Health and Human Sustainability

Sustainability:

- Diverse Transport Options
- Good Connections
- Stakeholders Involvement
- Renewable/Sustainable Power
- Mixed Use Functions
- High Density
- Preserve Open Space

Effects of Sustainable Planning Concepts on Society, Economics and Environment

Society	+	++	+	+	++	+/-	++
Economics	+	+/-	+/-	-	++	+	++
Environment	+	+	++	++	+/-	++	+/-

\+ Good -/+ Neutral - Bad
++ Very Good -- Very Bad

Regional Plan

Central Location - Bicycle-Friendly Distances

Bicycle vs. Car

Bicycling

Sustainability Planning Principles:

- Good Connections
- Diverse Transport Options

Einar Hjörleifsson Guðbjörg Brá Gísladóttir Katrín Halldórsdóttir Sóley Valdimarsdóttir

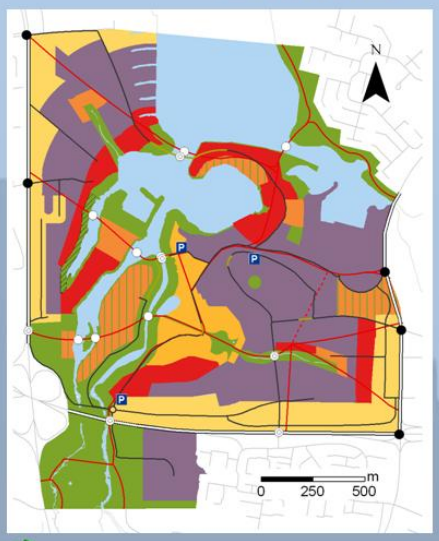
Center of Sustainable Living

Healthy Living - Bright Future

Master Plan

Legend

- Resedential area
- Mixed urban area
- Central area
- City center
- Public service area
- Open green areas for mixed use
- Mixed landuse
- Nature reservation
- Sea and rivers
- Main roads
- Secondary roads
- Limited traffic
- Main bicycle and pedestrian paths
- Pedestrian paths
- Interchange
- Traffic tunnel / bridge
- Pedestrian bridge
- Parking garage
- Bicycle Rental System



Green paths

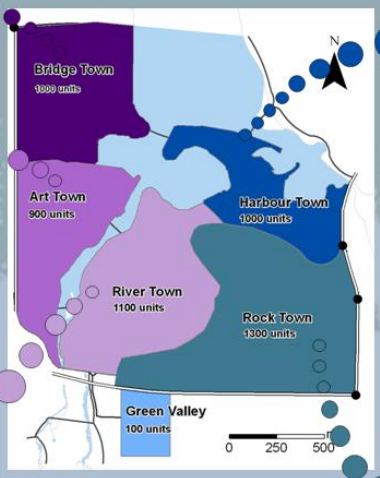
Road system

Development Progress

Max 300m to next restoration area

Sustainability Planning Principles:

- Good Connections
- High Density
- Preserve Open Space
- Diverse Transport Options
- Mixed Use Functions



Neighborhoods

Sustainability Planning Principles:

- High Density – 43 inhabitants per hectare

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Center of Sustainable Living

Healthy Living - Bright Future

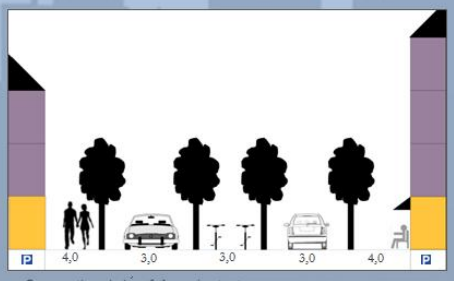
Detail Plan

8 parked bicycles require the same space as one car

Weather sheltered bicycle parking

Sustainability: Bicycles require little space

Bicycles are given priority



Cross-section A-A´ of the main street

Sustainability

Diverse Transport Options

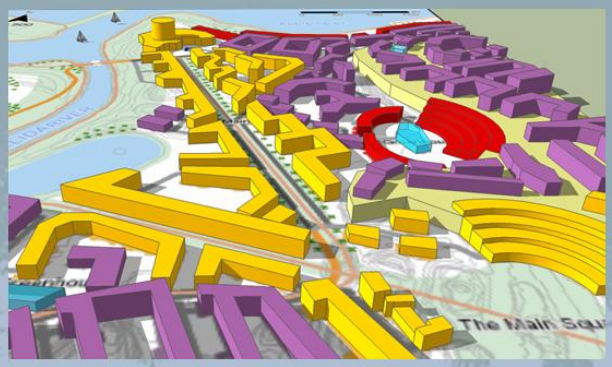
Cross-section B-B´ of the main square and fountain system

Sustainability

Renewable/Sustainable Power

City Center

A birds view. Densely built environment, with various types of houses in size, shape and function.



Main Square

Lazy Town Museum

Healthy Activities

Sustainability: Open Storm Water System and Green Roof

Health Restoration

Sustainability: Old buildings – new functions

Mixed Use Functions

Einar Hjörleifsson Guðbjörg Brá Gísladóttir Katrín Halldórsdóttir Sóley Valdimarsdóttir