



# SUSTAINABLE DENSITY IN STATION COMMUNITIES

Guidelines and indicators for sustainable density in station neighbourhoods in the Gothenburg area  
Example of sustainable densification in Ytterby

# SUMMARY

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Guidelines and indicators for a sustainable density in station communities in the Gothenburg region have been compiled in the following report. The guidelines and indicators are based on recommendations in UN Habitat and previous studies of land use and density in a Nordic context, among other things “Mervärdeskapande stadsutveckling (*Added Value-creating Urban Development*), Gothenburg City, GR et al 2017. The location of a station community has been defined as space within one kilometre of a railway station.

To study and exemplify what possibilities there are for regional station communities to both densify and at the same time achieve guidelines for sustainable density, both a mapping of the present density and its connection to services within regional station communities as well as a densification analysis of the Ytterby station community have been carried out. The Kungälv municipality and GR have agreed to collaborate in the SMART-MR EU project where the Ytterby station community forms part of the project’s case study. The Kungälv municipality is producing a comprehensive plan for Ytterby, which, among other things, shall give an account of how Ytterby can be densified from the inside out and increase the proportion of public transport passengers through planning.

The mapping of density and service in regional station communities shows there is a strong link bet-

ween the number of residents and workers and the offer of urban activities. When it comes to the diversity of services, however, a certain mix of residents and workers is needed.

But to attain sustainable density, a certain distribution of land use is required so that densification does not impact on the need for available open public spaces, traffic spaces, etc. Guidelines for sustainable density therefore include rough indicators for land use in general within station communities.

Here, guidelines for sustainable density have been compiled in a number of indicators which are dependent on district floor space, a mix of residents and workers, land use and the distance to a central station. The size of station communities has also been taken into consideration. District floor space is used here as an indicator for density.

A densification scenario for Ytterby shows it has a densification potential of 4,000 additional residences within 1 km of the station.

This densification scenario is based on 50% of the total buildable land within 500 metres of the station having been reserved for residences and the rest for office space and public services. Between 500 and 1,000 metres from the station, 25% of the buildable land has been reserved for office premises and public services. Given that every working individual, both in public service as well as the private sector, requi-

res on average 50 sq.m., this densification scenario provides an additional 4,000 workers within 1,000 metres of the station.

Base on the figure of two inhabitants per residence, the densification scenario consequently gives an additional 12,000 residents and workers within 1,000 of the station.

Also if Kastellgården 1:1 is included as an area for densification in the scenario, the number of residences within 1 km of Ytterby station would increase considerably.

Besides the guidelines for a sustainable density, the densification scenario is based on 32 different limitations of densification compiled in close cooperation with Kungälv municipality.

The densification analysis, using Ytterby as an example, shows good chances of attaining proposed guidelines of sustainable density in the region’s station communities.

“Key urban form drivers of energy and GHG emissions are density, land use mix, connectivity, and accessibility”

IPCC, 2015, Climate change 2014: Mitigation of Climate Change

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# INTRODUCTION

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## BACKGROUND AND OBJECTIVES

The Kungälv municipality and GR have agreed to collaborate in the SMART-MR EU project where the Ytterby station community forms part of the project's case study. The aim of the EU project is to draw up guidelines and sustainable measures for achieving sustainable transport systems. The Kungälv municipality is producing a comprehensive plan for Ytterby, which, among other things, shall give an account of how Ytterby can be densified from the inside out and increase the proportion of public transport passengers through planning.

With this background, GR and Kungälv municipality will jointly establish a suitably general density ratio for station communities in the Gothenburg region and examine the possibilities and consequences such a density would have for Ytterby. Furthermore, the municipality and regional authorities would also like additional planning support to show how an increase in density and diversity is to be achieved in station communities to increase urban quality and reduce the environmental and climate impact of the transport system.

## METHOD

### DATA COLLECTION

This compiles the present population density in terms of number of people per hectare within a radius of 500 metres and 1 kilometre.

### PROPOSALS GIVEN FOR GENERAL INDICATORS OF DENSITY IN STATION COMMUNITIES

A suitable density for communities with a population of 5,000-15,000 is proposed based on existing studies in the Gothenburg, Skåne and Stockholm regions. A suitable population density is set in relation to the significance the density has for urban quality and transport habits. Guidelines for density are given for plot floor space as well as district floor space. The guidelines could also be designed to depend on the walking distance to fast public transport.

### PROPOSED DENSIFICATION SCENARIO

A densification scenario is then produced for Ytterby based on a suitable density which fulfils the proposed density level(s). The densification scenario is based on a simplified analysis of the limitations that apply to buildable land and drivers in the form of the municipality's comprehensive plan and the result from "Värdeskapande stadsutveckling" (Value-creating Urban Development). Specifically, the densification scenario contains densification areas with a certain plot floor space index, for example 2.0, which

means the total gross floor area of the plot is twice the size of the surface area of the plot.

The densification scenario is based on the following conditions:

- Expansion of the station community from the inside out, densest closest to the station
- Expansion of the centre on two sides of the railway
- Expansion along routes connected to the station area
- Expansion along routes with good public transport services
- Expansion that couples Ytterby together with Kungälv and Rollsbo industrial estates

Risk of subsidence/geotechnology, climate mapping and infrastructure (major roads/railways) are taken into consideration where floor space is thought to be affected.

### ENVIRONMENTAL IMPACT STUDY

This analyses the consequences of urban qualities found in Value-creating Urban Development (urban activities and closeness to fast public transport). The significance of the densification scenario on transport habits can also be assessed on the basis of references to other studies. Consequences for those districts that do not involve densification must also be illuminated.

# EXPLANATION OF TERMS

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## PROPORTION OF DEVELOPED AREA

Is measured here as the ground area taken up by buildings divided by the total surface area. Consequently, all the land that is not an outdoor room. If the proportion of developed land becomes too great, there will not be enough place for outdoor rooms.

## PROPORTION OF LAND FOR PUBLIC SPACES

A simple way of describing how large a land area has been reserved for public spaces in an area and how large a proportion of the total land area is taken up by public spaces.

## POPULATION DENSITY

Describes the concentration of people within a certain distance.

In terms of the average household size, apartment sizes and auxiliary areas, a rounded-off value of 50 sq.m. GFA can be used per residence. A corresponding measurement can be used per workplace. Here, the GFA number clearly differs between sectors. A GIS analysis of Gothenburg city has shown that the average office floor area per worker is 53 sq.m.

## GFA

Gross floor area. Sum of all floor areas.

## DAYTIME POPULATION PERSONAL OUTDOOR AREA

Outdoor area belonging to a household or residence. A garden or patio for example.

## FLOOR SPACE INDEX

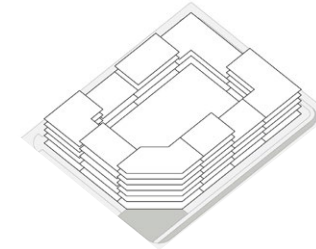
A floor space index is a measure of density that means the gross area within a limited zone is divided by the land area within the same zone.

## FREE AREA

All outdoor land not taken up with roads, paths or other infrastructure. For example, parks, squares, nature areas, gardens and courtyards.

## STREETSCAPE

An area open to the public that is used mainly for transport. Contains areas for pedestrian traffic and also often for vehicles. Also contains social areas, often on pavements.



### GFA CORRESPONDS TO FLOOR AREA

GFA (gross floor area) describes the sum of the areas on all floors within, for example, a building, property or plot.

## HECTARE

10,000 square metres. A square of 100x100 metres.

## BLOCK

One or more properties limited by a clear public space such as a street, park or water.

## PUBLIC SPACE

Free area open to the public according to regulations.

## NIGHTTIME POPULATION AREA FLOOR SPACE

A measure of district floor space has been used to measure density. District floor space is the total floor space in the area distributed over the land surface area. With a district floor space index of 1.0, there is consequently just as much floor space as there is land area. District floor space is controlled partly by how large a proportion of the land area is built on and the number of floors in each block. It is therefore a town of blocks need not be as high a tower block community. Generally, tower block communities leave more land undeveloped.

## PRIVATE OUTDOOR AREA

Outdoor area with limited availability that is not perceived as public. Private outdoor areas can be divided into personal and communal.

## SCENARIO

A scenario is the simulation of a future development. A scenario analysis means you describe a possible development based on a number of variables. The variables are often questions around which there are uncertainties but which at the same time are decisive to the future development.

## PLOT

Land area that is real property with associated property designation. May comprise one or more properties.

## PLOT FLOOR SPACE

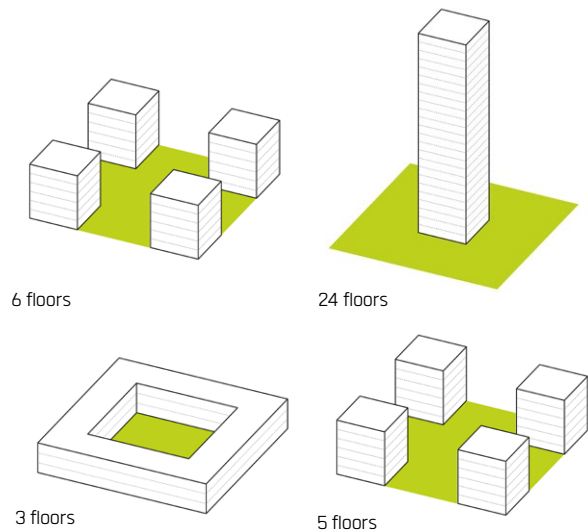
Plot floor space is the floor space on the plot divided by the surface area of the plot.

## OUTDOOR AREA

The area of a town that is not taken up with buildings. For example, parks, squares, nature areas, roads and courtyards.



PLOT AND AREA FLOOR SPACE RESPECTIVELY



DIFFERENT NUMBER OF FLOORS, SAME PLOT FLOOR SPACE

The floor space index should not be confused with the building design. Here are four plots with the same plot floor space index of 2.0 but with a completely different building design and number of floors.



# **GUIDELINES FOR SUSTAINABLE DENSITY**

# NEED FOR MEASURABILITY IN URBAN DEVELOPMENT

The Gothenburg region is facing major urban development challenges. While ambitious residential targets are to be met, the collective regional urban development also needs to be part of the solution to major communal challenges: a more coherent urban area, a sustainable transport system, better health and competitiveness in order to attract people and business. In order to be better at quality-assured and planned use of land and urban environments, individual municipalities and the Gothenburg region have both started to look for suitable methods of measuring urban form to better understand how plans agree with set targets (Gothenburg City 2017). For methods, measures and limits to be useful, they need to be simple enough for ease-of-use in daily planning while being scientifically anchored in order to be robust and believable.

Within all communal areas: health services, schools, business, measures and indicators are used in order to safeguard quality and comparability. Much of what today is appreciated by residents in various urban districts is also a result of concrete measurable requirements from the urban planning office, such as living street environments, closeness to services and culture in dense urban environments and child orientation and greenery in the Million Programme.

There is much research to show how the urban environment affects sustainability and quality of life.

Urban building research has shown many times that

the design of urban environments affects how they work, because social and financial values enable the growth of financial and social capital.

This has also been highlighted in UN Habitat, the UN's council for urban development. New Urban Agenda (2016), based on the UN's 17 sustainable development goals (2016), describes the importance of buildings, public spaces and infrastructure and how they interact. UN Habitat has also, with the support of research, established its own recommended indicators for, e.g., density, function mixing and public space.

The recent study "Värdeskapande stadsutveckling" (Value-creating Urban Development), Gothenburg City, et al 2017, shows that it is specifically planning and design of public urban environments but also regional public transport, i.e. that which both region and municipality have control of, that creates most value.

## WHAT IS AN INDICATOR?

An "indicator" is by definition a "means of detecting something or measuring an amount". This means in practice an analysis tool used to measure something meaningful. For the urban planner, this can mean, for example, how much green area there is, because we know that the amount of green area is significant to health and air quality.

Municipalities in the Gothenburg region must be able to safeguard a sustainable urban development with the support of the latest research on how cities function. As within other areas of society, this is achieved easiest and most transparently with the help of clear measures and indicators. They should be easy to use and understand but must be so precise and advanced that they capture the complexity of the city. An indicator is consequently a knowledge bearer and a means of control. The use of indicators, weighing and measuring quantities and qualities, is the basis for a rational decision-making process and has always been a fundamental part of the art of urban planning.



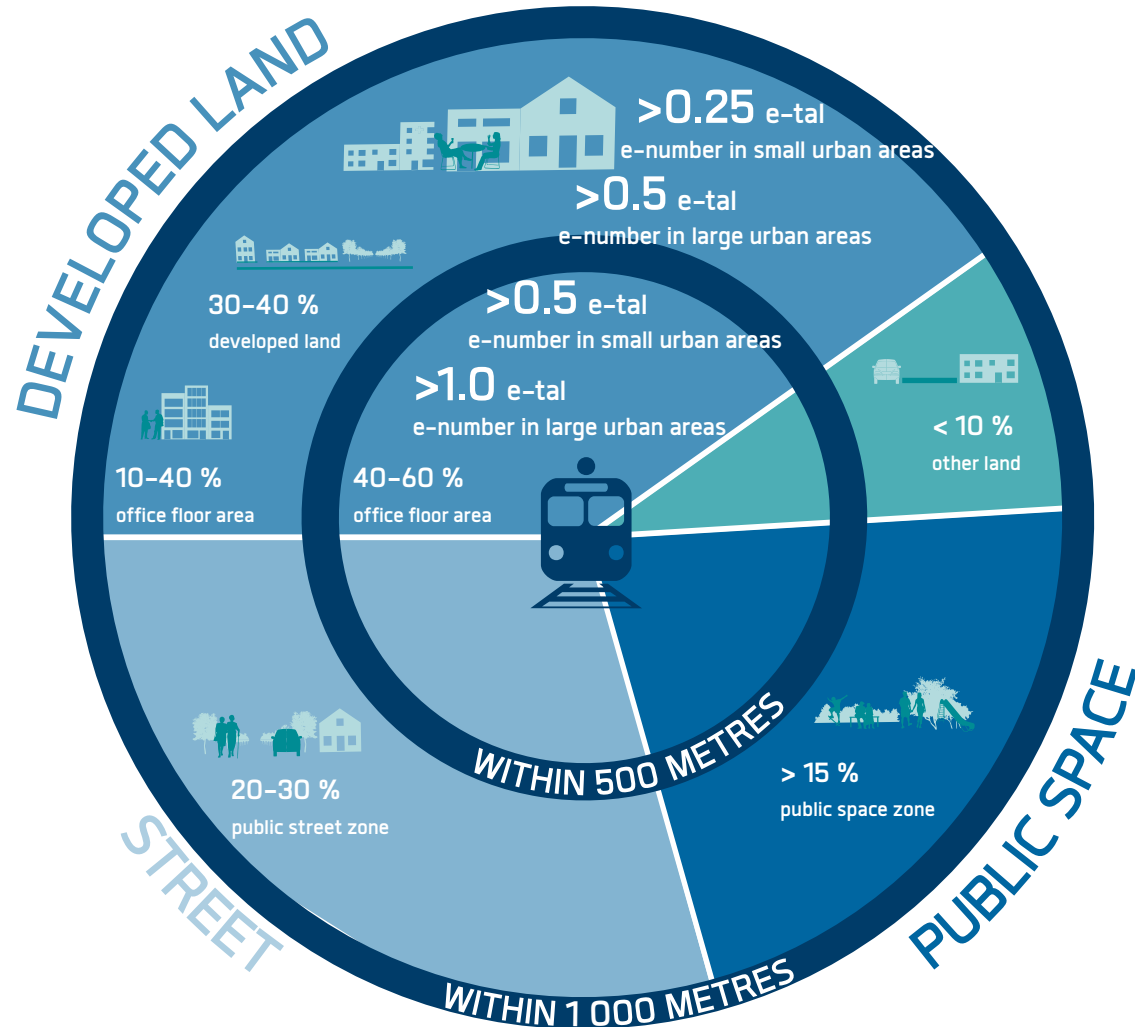
URBAN QUALITIES IN GOTHENBURG  
The result of the analysis of the factors – urban qualities – that create values on the housing market, office market and trade market. (Gothenburg City et al 2017)

# GUIDELINES FOR SUSTAINABLE DENSITY IN STATION COMMUNITIES

Today, there is a broad consensus on the need for sufficient density in order to achieve both a greater proportion of sustainable transport as well as the urban qualities required to make the region more competitive. Using the following indicators, a sustainable level of density can be achieved while other land uses will provide basic prerequisites for an attractive urban environment.

The following indicators have been based on both recommendations from UN Habitat (UN Habitat 2014) as well as previous studies of land usage and density in a Nordic context (Spacescape Asplan Viak 2016, Gothenburg City and GR el al 2016). A smaller reference study of density in the region's station communities has also been carried out to study the plausibility of indicators in a local context.

Indicators for a sustainable density in station communities build on suitable floor space indexes in relation to the distance from the station. Indicators are otherwise also given for a mix of residential floor area and office floor area as well as a distribution of land between different areas of use. In total, these indicators give an idea and framework for both developing a higher proportion of sustainable transport and a desired urban quality.



## GUIDELINES FOR THE FLOOR SPACE IN STATION COMMUNITIES

In order to support a high proportion of sustainable transport and urban quality, sufficient density is primarily needed in close proximity to the station.

**GUIDELINE 1: > 0.5 AREA FLOOR SPACE INDEX WITHIN 500 METRES FROM STATIONS IN SMALL URBAN AREAS**

**> 1.0 AREA FLOOR SPACE INDEX WITHIN 500 METRES FROM STATIONS IN LARGER URBAN AREAS**

**GUIDELINE 2: > 0.25 AREA FLOOR SPACE INDEX BETWEEN 500 AND 1.000 METRES FROM STATIONS IN SMALL URBAN AREAS**

**> 0.5 AREA FLOOR SPACE INDEX BETWEEN 500 AND 1.000 METRES FROM STATIONS IN LARGER URBAN AREAS**

Additional density far from the station increases car dependency while concentrated density within walking distance both increases urban qualities and reduces car dependency. Land in the proximity of a station, in other words, is a limited resource that should be managed with great respect taken to regional and municipal goals of sustainable and value-creating urban development. A more concentrated density around stations also gives other added values in the form of reduced costs for new road investments and the preservation of valuable recreational areas and agricultural land around station communities.

More extensive floor space in close proximity to tracked stations in today's sparsely built up and

small station communities along the Bohus coast should also potentially be the basis for increased investment in public transport and thereby better connections to other parts of the region with commuter trains. With a more concentrated density to the station neighbourhoods, the cost of local public transport would drop relative to a more scattered future urban development.

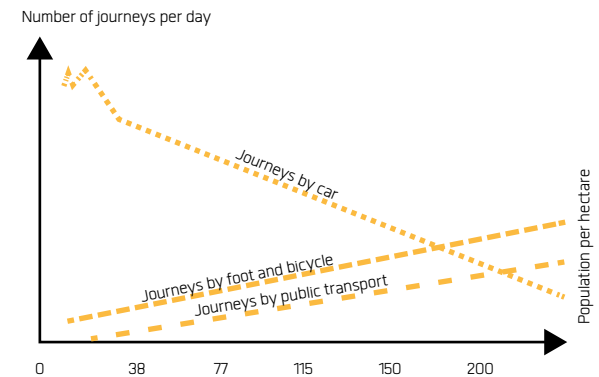
The station neighbourhood report defines a 1 km walking distance as an outer limit for a station neighbourhood. 1 km is also the maximum distance to rail-bound public transport that generates value in the Stockholm region (TMR 2011). Meanwhile, studies also show that the probability of using public transport is twice as high if the distance to a station is less than 600 metres. (Skåne County Council 2010). Nevertheless, a distance of 500 metres proved to be the maximum distance to generate value on the house market in the Gothenburg region (Gothenburg City and GR 2016). It is therefore necessary to distinguish between close station proximity and station neighbourhood and put higher requirements on density within 500 metres than within 1 km and at the same time densification within 1 km should be prioritised before floor space in other parts of the urban area.

District floor space index is used here as an indicator for floor space. District floor space is determined by how much GFA (floor area) there is relative to the total land area in a district. In the mapping of density in the region's station communities, it has been shown that a district floor area index of around 0.5 within a distance of 500 metres from a station results in an estimated 5 out of 5 service categories (food shop, general store, cafe/restaurant, culture, commercial

service). 0.5 is therefore proposed as a lower limit for sufficiently sustainable density in station communities within 500 metres of a station.

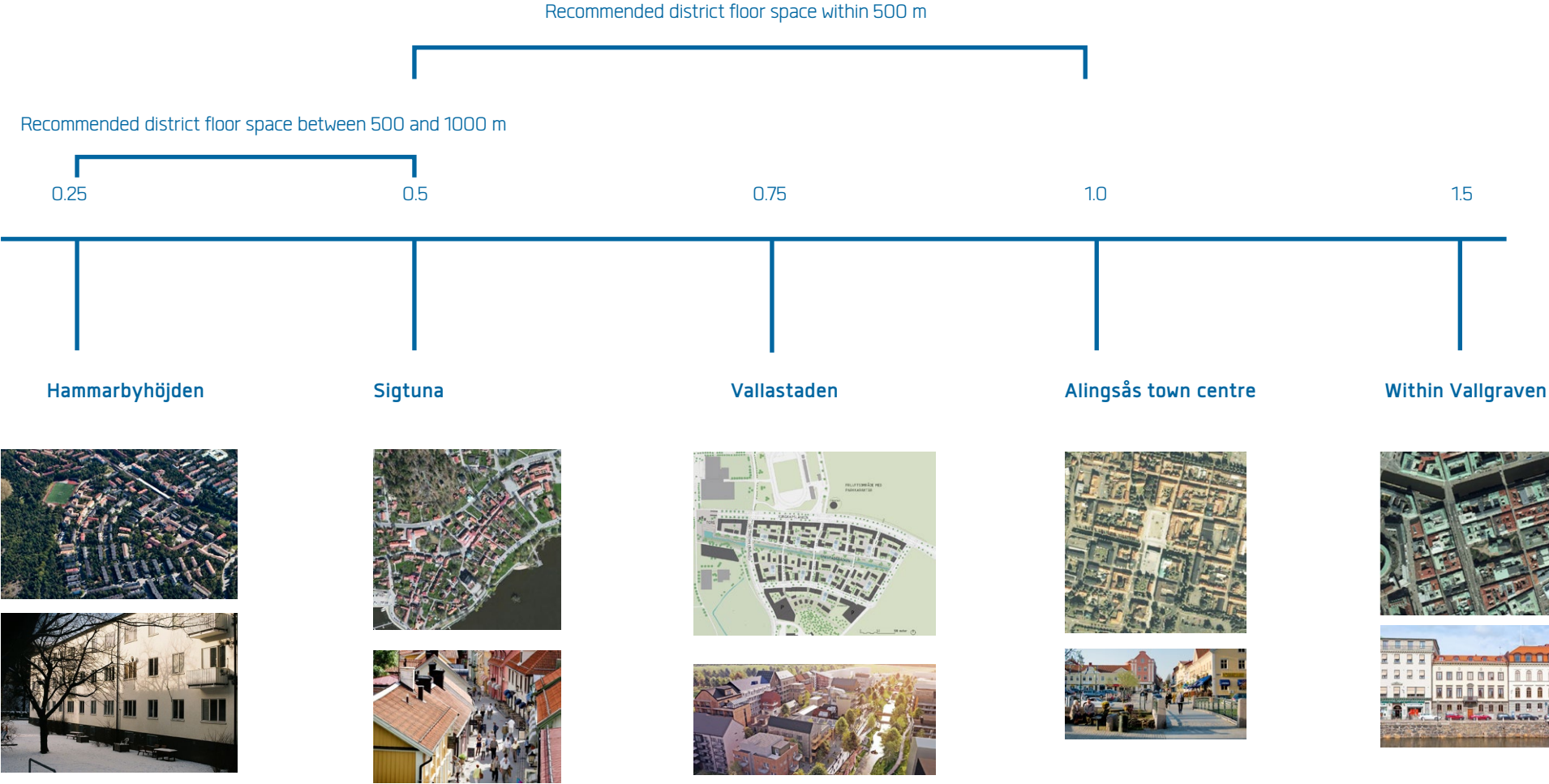
In larger urban areas where drivers are stronger for densification and where district floor space indexes already exceed 0.5, the index 1.0 can be used as a suitable indicator (refer to city centres in Alingsås and Kalmar as well as Vasastaden in central Gothenburg). Using 1.0 enables the possibility of a dense, coherent and green city at the same time as the scale of floor height of buildings can be adapted to that of a small town scale and sufficiently large gardens can be created on developed land. While using 1.0 within 500 metres of a station, UN Habitat's recommended density of 150 persons/hectare can be achieved (UN Habitat 2014).

In the area between 500 and 1000 metres from a station, half the district floor space relative to the indicator for floor space within 500 metres is proposed as market forces here are not as strong.



RELATIONSHIP BETWEEN DENSITY AND TRANSPORT SHARE. SOURCE: UN HABITAT (2014)

# REFERENCES: DISTRICT FLOOR SPACE



# CALCULATION OF NUMBER OF RESIDENTS AND WORKERS

The table to the right shows how we calculate to get a population number based on two different density indicators and density levels.

By multiplying district floor space with land areas, the total amount of GFA (floor area) can be obtained. This is then distributed over residents, workers and public services. A GFA of 50 sq.m. per person has been used to calculate the number of residents and workers within the different distances. Given these suppositions, the guidelines for floor space give a potential for 13,500 residents and workers within 1 km of a station in current small urban areas (5-15,000), 27,000 residents and workers in larger urban areas (populations higher than 15,000 today).

## FOR SMALLER STATION COMMUNITIES:

**80 residents and workers**  
per hectare

## FOR LARGER STATION COMMUNITIES:

**160 residents and workers**  
per hectare

\* The number of visitors or workers within public services (schools, healthcare) has not been included in the calculation of the total number of residents and workers and a flat-rate share of 10 % of the total GFA has been allocated for these activities.

	District Floor Space Index 0.5		District Floor Space Index 1.0	
	As the crow flies 500 m ( $\pi$ 500 <sup>2</sup> )	Per hectare (100x100 m)	As the crow flies 500 m ( $\pi$ 500 <sup>2</sup> )	Per hectare (100x100 m)
Land area (m2)	785 000	10 000	785 000	10 000
District floor space	0,5	0,5	1	1
Total GFA (floor area)	390 000	5 000	785 000	10 000
Proportion residents	50 %	50 %	50 %	50 %
Proportion workplaces	40 %	40 %	40 %	40 %
Proportion public services	10 %	10 %	10 %	10 %
GFA residential	200 000	2 500	400 000	5 000
GFA offices	160 000	2 000	320 000	4 000
GFA public services	40 000	500	80 000	1 000
Number of residents	3 900 (50 m <sup>2</sup> /pers)	50	7 800	100
Number of workers*	2 900 (50 m <sup>2</sup> /pers)	33	5 800	65
<b>Total population</b>	<b>6 900</b>	<b>80</b>	<b>13 600</b>	<b>165</b>
Residences (2 pers/residence)	2 000	25	4 000	50

## FROM E-NUMBER TO RESIDENCES

The table shows how different measures of density and degrees of floor space can translate into number of residences and population.

## GUIDELINES FOR LAND USE IN STATION COMMUNITIES

**Dense but also green and available towns can contribute to a reduction in emissions of greenhouse gases and improved air quality. They can reduce the dependence on car travel and improve general health as more people will be stimulated to walk, cycle and use public transport.**

**GUIDELINE 3: 30-40 % OF LAND AREA SHOULD COMPRISE DEVELOPED LAND WITHIN 1 KM OF A STATION**

**GUIDELINE 4: 20-30 % OF LAND AREA SHOULD COMPRISE PUBLIC STREETS WITHIN 1 KM OF A STATION**

**GUIDELINE 5: AT LEAST 15 % OF LAND AREA SHOULD COMPRISE PUBLIC SPACES WITHIN 1 KM OF A STATION**

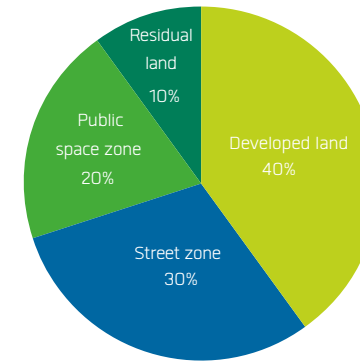
**GUIDELINE 6: MAX 10 % OF LAND AREA SHOULD COMPRISE MISCELLANEOUS LAND**

In order to create an attractive city, land usage must give sufficient space for developed land, parks and streets.

Research into urban planning (e.g. Florida 2006 and Speck 2012) has shown that local urban qualities have a big impact on which cities grow more than others. Studies of the residential markets in Stockholm, Gothenburg and Halmstad have shown that

the demand for residences is largely driven by the walking distance to urban services such as parks and fast public transport (TMR (2011), Halmstad Municipality (2014) and Gothenburg City and GR (2016)). One condition for achieving the guidelines on floor space in close proximity to stations while creating sufficient space for streets and qualitative green areas, is that at least 30-40% of land should be developed land. With less developed land than this on the other hand, a very high level of plot floor space is needed to achieve the guidelines for sustainable density. This will result in a plot floor space index that can then lead to both inferior gardens and large-scale development that can be perceived as strange considering the present small-scale development in station communities.

In "Five principles for Streets as Public Spaces and Drivers of Urban Prosperity" (UN Habitat 2015), it is shown that 30% of the land area is needed for streets to give the road network sufficient crossing density to be considered pedestrian friendly. Crossing density has in research studies been shown to impact positively on pedestrian share (Ewing and Cervaro 2012). As a reference, Vasastaden constitutes 30% of all land area used for streets. Meanwhile earlier studies (Spacescape Asplan Viak 2016) have shown that many of today's pedestrian-friendly urban districts, for example Grunerløkka in Oslo, do not reach up to 30% but well over 20%. This span between 20 and 30% of streets can therefore be seen as a good indicator of share of street zones.



EXAMPLE OF EFFICIENT DISTRIBUTION OF LAND USAGE

The proximity of valuable green areas to water and in particular to parks is a significant urban quality in both the Stockholm and Gothenburg regions (Gothenburg City and GR et al 2016, TMR 2011). Allowing space for green tracks and green areas is also an important prerequisite for eco-system services for efficient management of surface water. UN Habitat has reached a recommendation of at least 15 per cent public spaces (UN Habitat, 2014). As a reference, dense urban districts here such as Hammarby sjöstad in Stockholm and Vasastaden in Gothenburg have a proportion of over 20%. As an indicator, at least 15% within 1 km of a rail-bound station is suggested here.

In reality though, there is often quite a few wasteland areas with unclear usage. During future densification, these residual areas should be minimised. Based on previous Spacescape studies (Spacescape 2015), 10% can be a plausible limit for these miscellaneous areas.

## GUIDELINES FOR STATION COMMUNITIES' MIX OF RESIDENTS AND WORKERS

**A mix of residences and offices supports the local labour market, local services and reduced car dependency.**

**INDICATOR 7: 40-60 % OF DEVELOPED LAND SHOULD BE OFFICE FLOOR AREA WITHIN 500 METRES OF A STATION**

**INDICATOR 8: 10-40 % OF DEVELOPED LAND SHOULD BE OFFICE FLOOR AREA WITHIN 500 AND 1,000 METRES OF A STATION**

In "Five Principles for Streets as Public Spaces and Drivers of Urban Prosperity", UN Habitat recommends 40-60 % office floor space in order to support the local labour market, local services and reduce car dependency. This mix also appears to be an important indicator for a high pedestrian share in Ewing and Cerveros' meta-study of transport and urban development (Ewing Cervero 2012).

The Danish study "Stationsnærhedspolitikken i hovedstadsområdet – baggrund och effekter" shows that it is particularly the localisation of workplaces to a close proximity to stations that is of great significance to the workers' proportion of car travel (Skåne County Council 2012). The study "Värdeskapande stadsutveckling" showed that also the proximity to fast public transport can have a decisive significance on the level of office rentals (Gothenburg City, GR et al 2016).

In other words, it seems to be of great importance to prioritise the proportion of office space in close proximity of stations, i.e. 500 metres. Nevertheless, a certain proportion of office space is needed within 1,000 metres, not least to give access to necessary public service. However, the financial sustainability of commercial premises is usually lower here.

Mapping of density in regional station communities shows a relatively even distribution between residents and workers within 500 metres of stations.

Maintaining a high proportion of workers in the central parts is an important strategy for the further development of station communities. Especially when in many cases it can be difficult to attract new businesses and activities in conjunction with new construction to more peripheral sites in the region. In conjunction with the densification of more central locations, it is extremely important to get premises at street level in the relatively most commercially viable locations. One example of a station community that has succeeded well in integrating premises in conjunction with the densification of station neighbourhoods is Härryda Municipality, which successfully transformed Mölnlycke Centre to a living location with commerce, residences and offices.



**DENSIFICATION WITH BOTH OFFICE AND RESIDENTIAL FLOOR SPACE IN MÖLNLYCKE CENTRE**

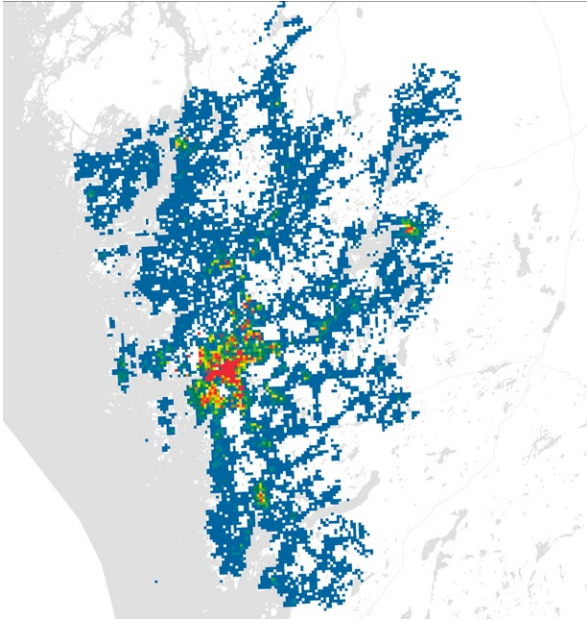


# DENSITY IN REGIONAL STATION COMMUNITIES

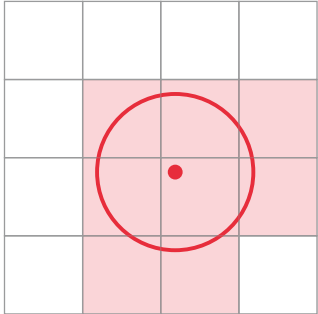
# METHOD AND DETAILS

The objective of the statistical analysis is to empirically test to what extent the density of daytime and nighttime populations correlate with the range of urban activities in station communities in the Gothenburg region. The statistical connection that we are presenting is used to give an approximate picture of the range of urban activities that can be expected in different densification scenarios in Ytterby.

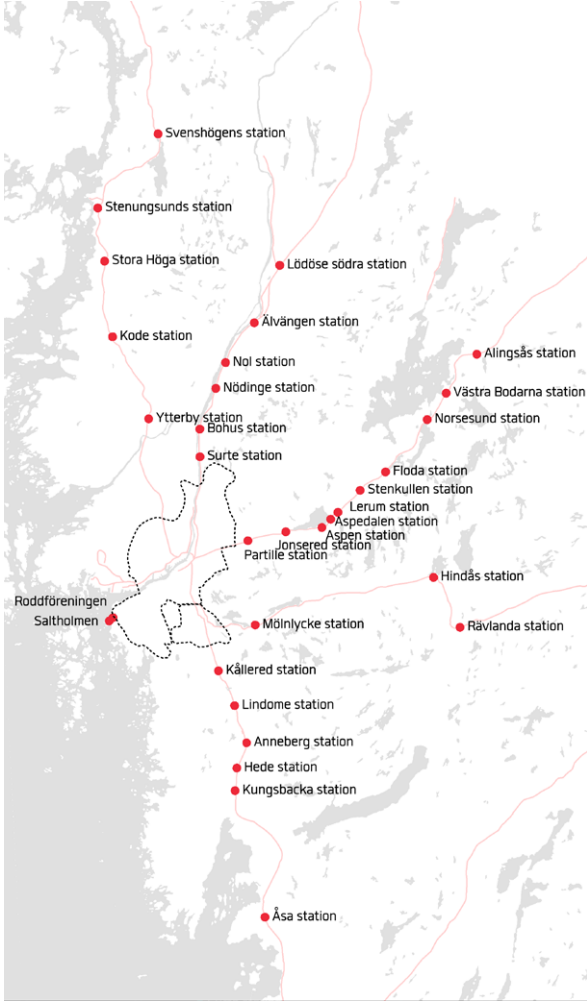
The first picture to the right shows population (daytime and nighttime populations) placed in boxes with 500 m sides. All data for the Gothenburg region we have analysed comes from this data layer. Since the aim of the analysis is to study sustainable density in station communities, we have had to define and separate the data that concerns station proximity. Against the background of our large reference catalogue of urban development studies, we can see that the central parts of regions have partially another logic concerning density and range, which is why they are of no interest to us in this report. We have therefore, based on the grid's geographic scope, found 32 station communities outside the intermediate city in Gothenburg and the central parts of Mölndal (see map). Of them, 30 were located around railway stations and two around tram stops (Rodd-förening and Saltholmen). The reason for including the latter two is that they fall outside the geographical boundary given above for the region's most central parts and that they, like the other 30 station communities, have a high-capacity public transport service.



**POPULATION WITHIN 500 METRE GRID**  
 1 ■ 300 ■ 600 ■ 900 ■ 1200 ■ 1500 ■ 1800 ■ 2100 ■ 2400 ■ >2400



**ILLUSTRATION HOW CIRCULAR BUFFERS INCLUDE DATA FROM 500 METRE GRID**



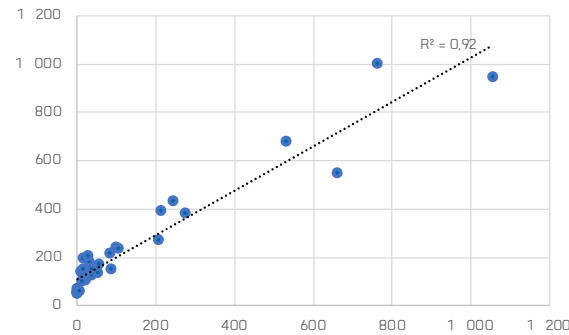
**SELECTED STATION COMMUNITIES IN THE GOTHENBURG REGION**

A total of 32 stations in the region outside the intermediate city in central parts of Gothenburg and Mölndal

The relative coarseness in the grid (500x500) means we must select the data in statistical buffers with a 500 metre radius and decide that all intersections that at least overlap a circle give their value to that circle (see figure on previous page). In this way, we include all densities that are within 500 metres. The disadvantage, which we consider to be of limited significance, is that the density we apply to circles in some cases can be further from the station (just below 1 km). But considering that many environments around stations often lack continuous density outside 500 metres, the error will be of a limited magnitude.

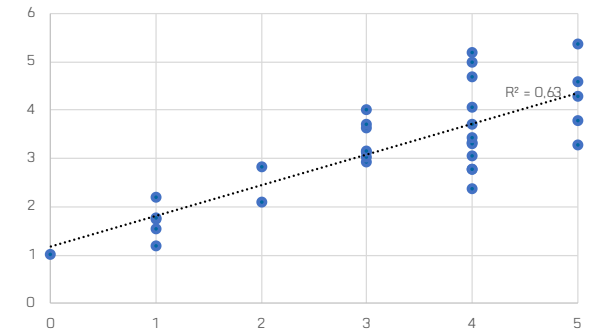
The statistics in the grid that we have used are nighttime population, daytime population, diversity in range and daytime population within urban activities. Data for diversity in range describes how many trades there are in the grid. The five trades included are: food, durables, culture, restaurant and diverse commercial service. If, for example, all five of these trades are represented in one grid reference then that reference is given the value 5. But if there are only three restaurants in the grid reference then it is given the value 1. The number of activities in a trade are therefore not included.

Daytime population in urban activities is used as a proxy for the number of urban activities. Urban activities are cultural activities, restaurants, durables and diverse commercial service. We would preferably see how density relates to actual range of urban activities, but as those details are missing, we instead use daytime population in urban activities. In order to talk about urban activities (and not just daytime population in these trades), we have used



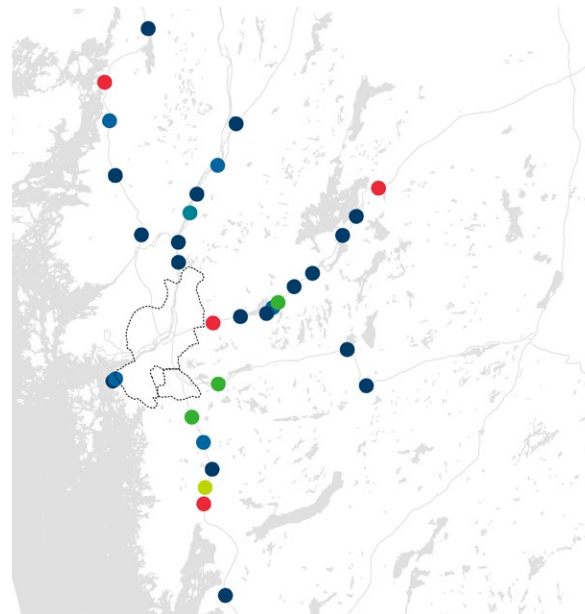
**CORRELATION DIAGRAM OF DAYTIME POPULATION IN URBAN ACTIVITIES - ESTIMATED DAYTIME POPULATION**

The estimated number of urban activities is based on the number of workers within 500 metres of station communities (n=32).



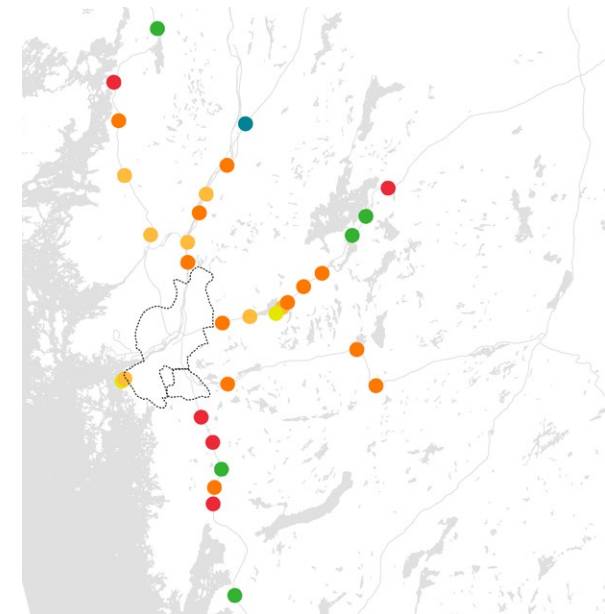
**CORRELATION DIAGRAM MAX DIVERSITY OR ACTIVITIES - NIGHTTIME POPULATION AND MIXES**

The estimated diversity is based on the number of residents and mix and workers in % within 500 metres of station communities (n=32).



**DAYTIME POPULATION IN URBAN ACTIVITIES**

0 ■ 50 ■ 100 ■ 150 ■ 200 ■ 250 ■ 300 ■ 350 ■ 400 ■ >450



**MAX DIVERSITY OF ACTIVITIES**

1 ■ 2 ■ 3 ■ 4 ■ 5

the workplace register in Stockholm as reference and there found that urban activities have an average of 8 employees. Based on these references, we can assume the same number is plausible in the Gothenburg region and therefore divided the daytime population in urban activities with 8 to obtain an estimated number of urban activities.

## RESULT

Through statistical analyses, we have found two density connections of interest. The first is the number of urban activities, where we see that 92 per cent correlates with the daytime population. The second correlation is weaker, 63 per cent, and concerns the correlation between 1) nighttime population and the mix of daytime and nighttime population, and 2) the diversity of the activities. All connections in the model are positive in as much as higher nighttime population and higher mixture, and higher daytime population respectively are in agreement with greater diversity and higher daytime population respectively in urban activities. Mapping shows the actual diversity and size of daytime population in urban activities.

Givet sambanden ovan skulle exempelvis Ytterby öka från idag tre till fyra servicekategorier och från 20 till 30 urbana verksamheter inom 500 meter från stationen, såvida antalet boende ökade med 100 och antalet arbetande med 700. Med 2 100 nya boende och 2 700 arbetande skulle Ytterby nå en skattad andel på fem av fem servicekategorier och cirka 50 urbana verksamheter. Utifrån tabellen "Från e-tal till bostäder" framgår det att 8 000 boende och arbetande får plats inom 500 meter från stationen om områdesexploatering är 0,5. 0,5 i områdesexploatering kan därför ses som tillräcklig täthet för åtminstone mindre stationssamhällen.

# DENSIFICATION SCENARIO YTTERBY

# MUNICIPAL AIMS FOR YTTERBY

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Ytterby is a station community with a population of around 8.000 residents and workers five km from Kungälv. Present land use within walking distance from Ytterby station comprises mainly residences, some activities along the railway track and small town-centre activities, a large supermarket and municipal services.

Since Ytterby is located on the prioritised regional main artery for public transport, there is a great need of densification based on the region's and municipality's goals for regional development.

Ytterby is a hub in the public transport network as the bus station is trafficked by 13 bus routes. It also takes only 17 minutes by train to Gothenburg Central station. The aim of the municipal general plan from 2010 is to densify Ytterby from the inside out.

A concentrated effort in the densification of locations that are more close to stations reinforces the existing town centre and more people are given the opportunity to be car-free in their everyday life. A concentrated densification also leads to less wear and need for development of the existing road network. Concretely, a concentrated densification here means the area than can be reached from 1 km of the station. In this way, the municipality's present planning aims for Ytterby go hand-in-hand with the guidelines that have been proposed here for sustainable densification of station communities generally in the region.

The municipal council in Kungälv has now initiated a deep-going overview plan for Ytterby. The need for a deep-going overview plan stems from several on-going planning processes, high-pressure development, increased need for municipal activities, large proportion of municipally-owned land, strategic municipal growth goals, extension of the Sparråsvägen road and discussions around the Bohusbanan train line.

While the conditions for a more extensive densification of Ytterby are now good, the municipality also wants the densification to be coordinated in such that it also supports a sustainable urban, municipal and regional development.



YTTERBY STATION HOUSE

# METHOD FOR DENSIFICATION SCENARIO

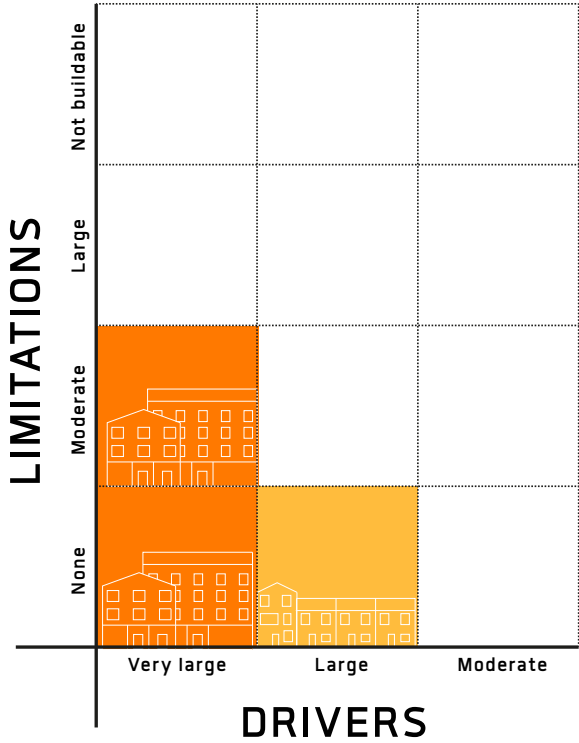
The densification scenario for Ytterby is based on a model where both drivers and limitations within 1 km of Ytterby station have been compiled in a GIS.

With regards to drivers in the model, they originate from the guidelines on sustainable density included in the previous model for sustainable density in station communities. Potential areas for densification within 500 metres of the station have very large drivers and areas within 500 to 1.000 metres have large drivers. With regard to limitations, they have been compiled into four level, from no limitations to unbuildable areas.

A densification scenario has then been established in accordance with the model on the right. Areas where drivers are greater than the limitations have been identified as being suitable for densification areas. The size of the densification potential has then been calculated from a dynamic plot floor-space index that is higher than in the more stationary locations.



DRIVERS OF DENSIFICATION BASED ON DISTANCE TO TRAIN STATION



AREAS BUILT IN DENSIFICATION SCENARIO

# LIMITATIONS OF DENSIFICATION

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The list on the right shows the limitations of densification in locations within 1 km of Ytterby station. The mapping of limitations is based on the model that Spacescape previously used to analyse densification potential in Gothenburg City (2014) and Mölndal (Mölndal 2017). The choice of limitations and the interpretation of the degree of limitation for each of these has taken place in close dialogue with the municipality of Kungälv.

- AREA OF ACTIVITY WITHIN 1000-1500 M RETAINED
- AREA OF ACTIVITY
- RAILWAY/HIGHWAY 168 BUFFER 25 M EACH SIDE
- NATURA 2000 - BIRD DIRECTIVE AND HABITAT
- NATURE RESERVE
- KEY BIOTOPES
- COAST PROTECTION
- WETLAND INVENTORY CLASS 1
- BROAD LEAF FOREST AND MEADOWS AND GRAZING LAND CLASS 1
- ANCIENT MONUMENTS, AREAS
- DEVELOPED LAND
- ON-GOING PLANS
- AREAS OF ACTIVITY WITHIN 500-1000 M CHANGED
- LOCAL LOW POINTS
- HIGHWAY 604 BUFFER 15-30 M
- POWER LINE BUFFER 50 M
- NATURAL VALUES (SWEDISH FOREST AGENCY)
- NATIONAL INTEREST IN OUTDOOR LIFE AND NATURE CONSERVATION
- WETLAND INVENTORY CLASSES 2 & 3
- ARABLE LAND MORE THAN 1 KM FROM STATION BROAD LEAF FOREST CLASSES 2 & 3
- MEADOWLAND AND PASTURE
- MEADOW AND GRAZING LAND CLASSES 2 & 3
- NATIONAL INTEREST CULTURAL RESOURCES MANAGEMENT
- CULTURAL RESOURCES IN MUNICIPALITY
- ANCIENT MONUMENTS, LINES AND POINTS
- AREAS OF ACTIVITY WITHIN 500 M CHANGED
- DECIDED PLAN ASSIGNMENTS
- VALUABLE AGRICULTURAL LANDSCAPE
- ARABLE LAND WITHIN 1 KM OF STATION
- SUSPECTED AND ASCERTAINED CONTAMINATED AREAS
- UNDULATING GROUND

Not buildable

Major limitations

Moderate limitations

32 MAPPED LIMITATIONS

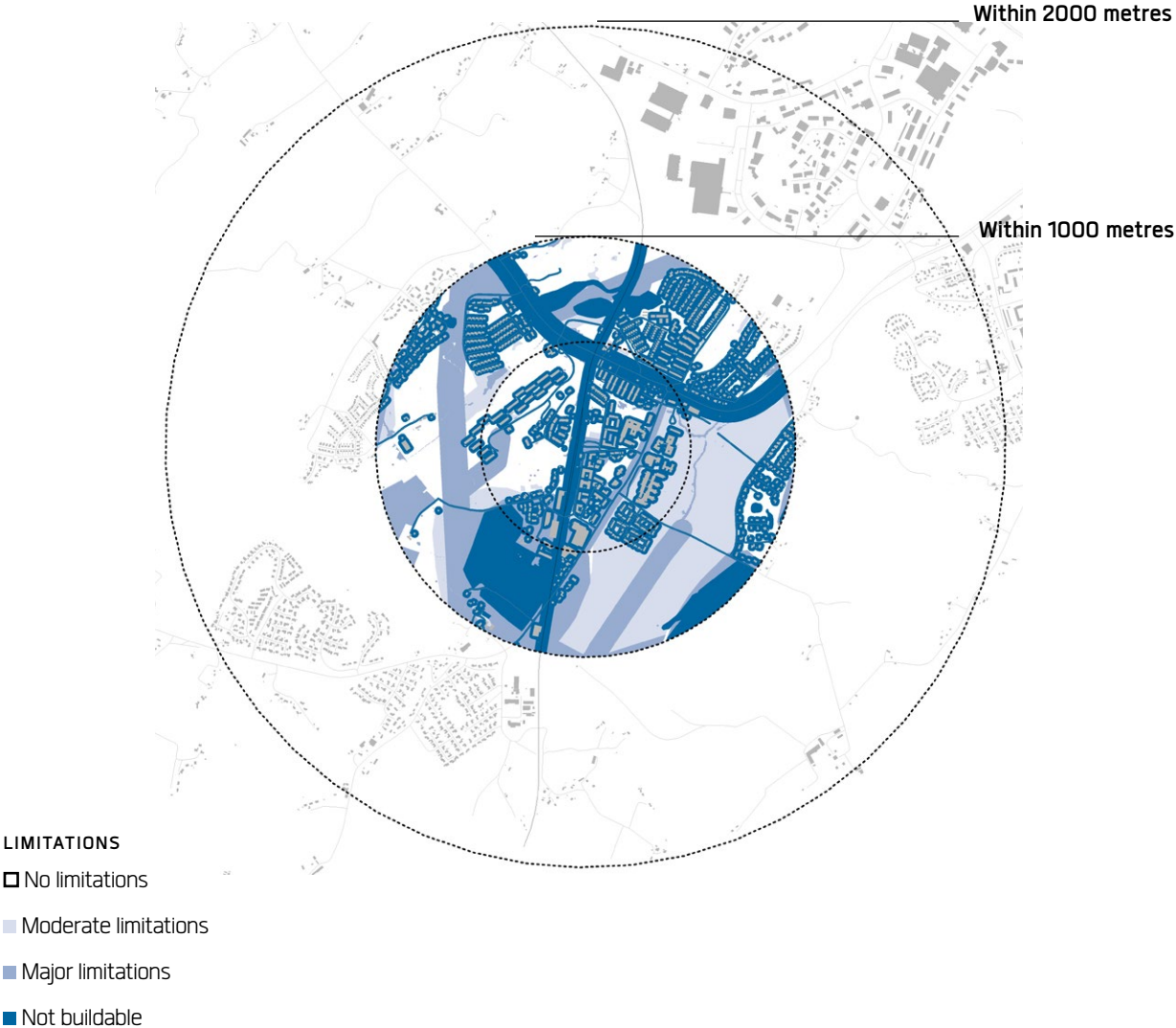


# LIMITATIONS OF DENSIFICATION

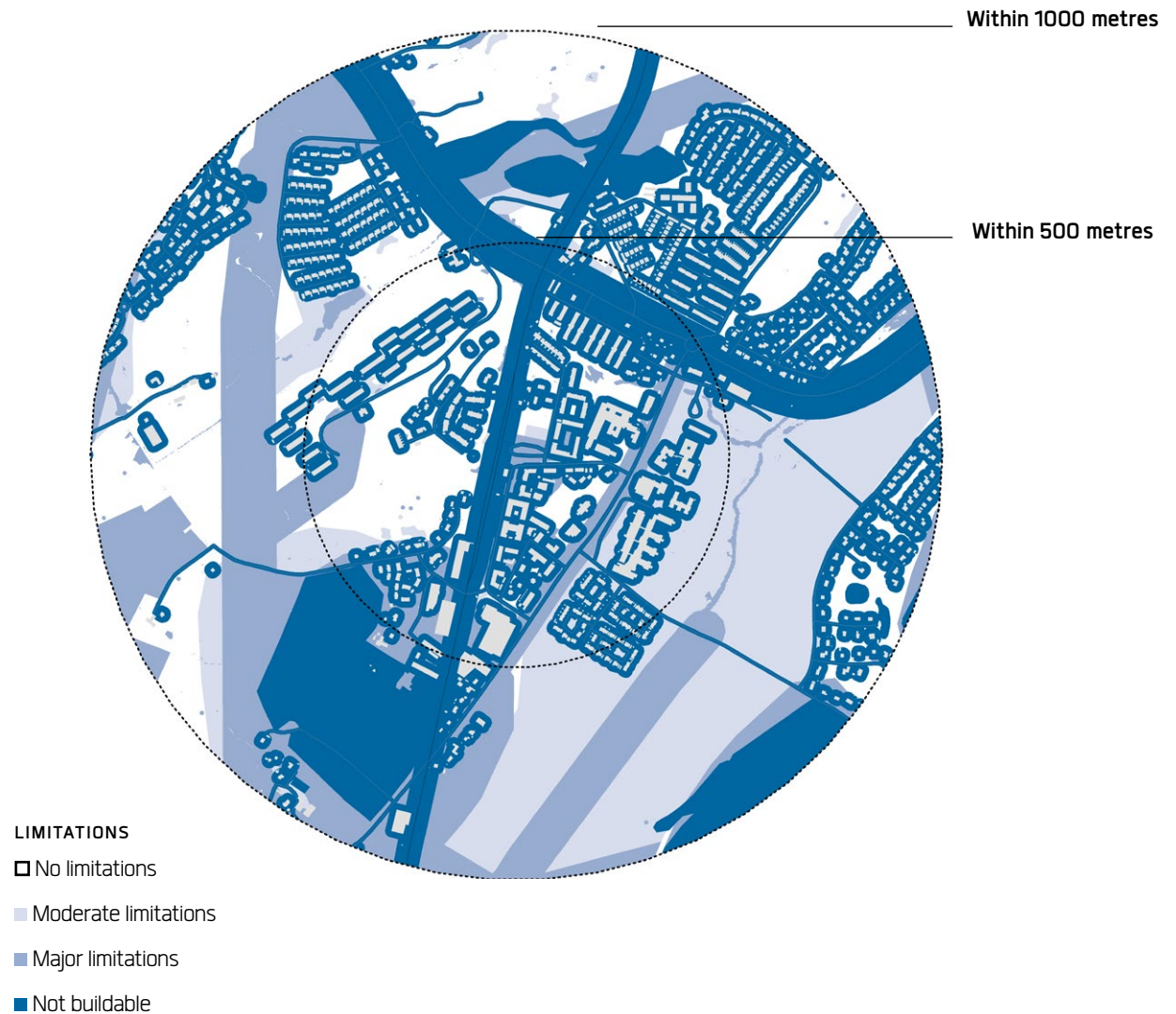
## MINOR LIMITATIONS OF DENSIFICATION IN WESTERN PARTS OF YTTERBY CLOSE TO STATION

The map on the right shows the limitations of densification in locations within 1,000 metres of Ytterby station.

There are several areas in central Ytterby that have minor or no limitations, in particular the western parts. This indicates a major potential for densification.



# BEGRÄNSNINGAR FÖR FÖRTÄTNING: INZOOM



# BUILDABLE AREAS IN DENSIFICATION SCENARIO

## A QUARTER OF LAND WITHIN 500 METRES OF YTTERBY STATION HAS MAJOR DENSIFICATION POTENTIAL

In the densification scenario, areas within 500 metres of the station are developed with no or moderate limitations. Only surfaces with no limitations are developed outside 500 metres.

With these conditions, the densification scenario shows major densification potential within 500 metres of the station in Ytterby. 25% of the area (200,000 sq.m.) here has no or moderate limitations.

Within 500–1,000 metres of the station there is above all a densification potential in the western and northern parts. Agricultural land in the south-east has only moderate limitations however. With an even greater driving force for densification in Ytterby, these more major potential densification areas should be able to result in a large addition to the otherwise already major densification potential.

Based on the detailed overview plan, new production of residences ought to be minimised beyond the 1,000 metre line from Ytterby station until the areas within have been developed.



### DENSIFICATION AREAS

- Densification areas within 500 metres of the station with no or moderate limitations.
- Densification areas within 500-1000 metres of the station with no limitations.

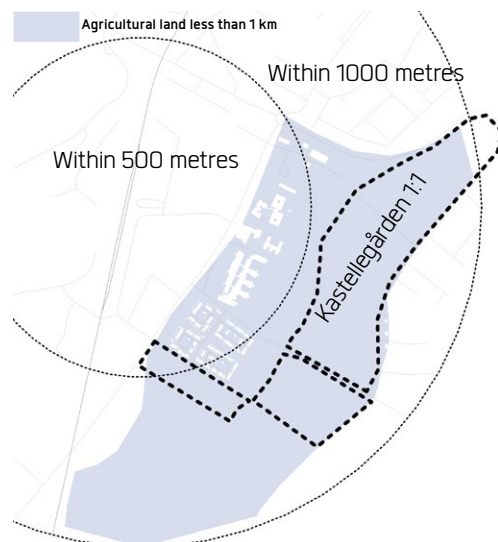
# LIMITATIONS OF DENSIFICATION: KASTELLEGÅRDEN 1:1

The maps below show the agricultural land belonging to the property Kastellegården 1:1 with a dashed line. Kastellegården 1:1 is today owned by the National Property Board. Through the Ministry of Industry, the municipality of Kungälv has been asked whether it is interested in purchasing part of the property on which to build residences.

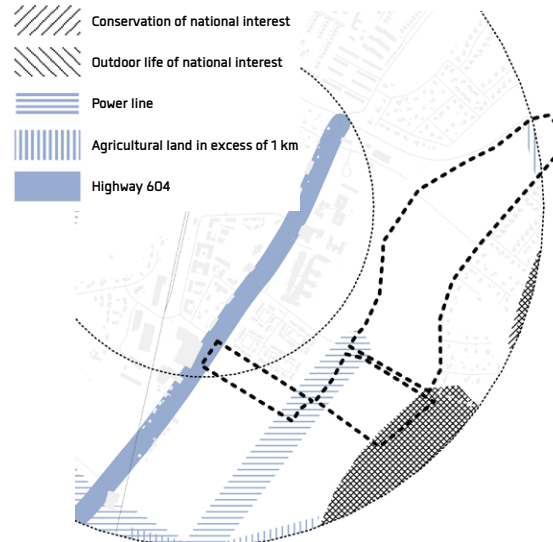
In order to indicate the limitations of densification that exist here, the property has been overlaid with established moderate and major limitations as well as areas considered to be unbuildable at present. The mapping shows that it is above all agricultural land in close proximity to the station that constitutes a limitation for the densification of Kastellegården.

This limitation is however considered to be moderate by the municipality. In combination with the property exactly bordering the area with 500 metres of the station, a densification here can still be regarded as being in line with the general guidelines on sustainable densification proposed herein.

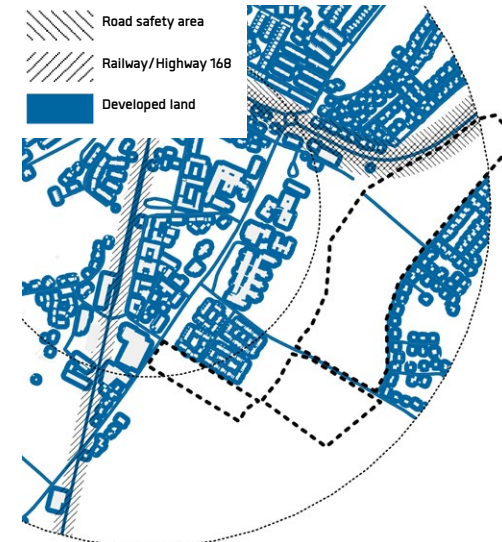
## MODERATE LIMITATIONS



## MAJOR LIMITATIONS



## NOT BUILDABLE



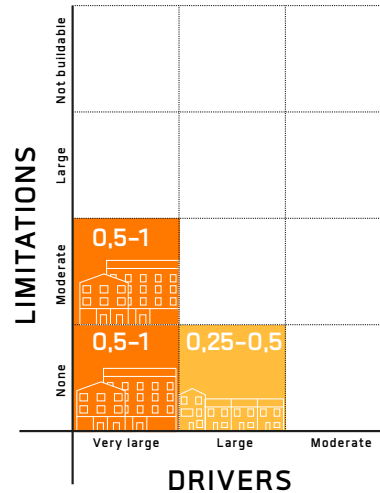
# SUITABLE PLOT FLOOR SPACE

Based on guidelines for sustainable densification at an area level in the previous chapter, different floor space indices at a plot level have been studied. Plot floor space here is not a goal in itself but can be seen as a way of achieving sufficient density at an area level. The studied span of plot floor space is adapted to a small town scale (see next page for development references). It is also plausible in the densification scenario to premise a higher plot floor space within 500 metres since the guidelines for district floor space here are higher.

Sufficient density is attained with a plot floor space index of 1.0 according to the guidelines. This is due largely to the substantial areas that are available for densification. A plot floor space index of 1.0 means that suitable types of development such as dense blocks of houses and also low-rise apartment blocks are possible.

Meanwhile, calculations on the right show that a plot floor space index of 1.0 is not enough to attain sufficient density within 500-1000 meters. In order to achieve this, either a higher plot floor space index or a densification of Kastellagården 1:1 is required. This should be studied further.

In the calculation of district floor space, 20% of the densification areas have been reserved for street zones in conjunction with new development.



DUE TO BIGGER DRIVERS, PLOT FLOOR SPACE IS HIGHER WITHIN 500 METRES OFF THE STATION

## Guidelines for district floor space within 500 metres: 0.5

**Present: 0.36\***

**With densification scenario: 0.44-0.56** (plot floor space index 0.5-1)

## Guidelines for district floor space between 500-1,000 metres: 0.25

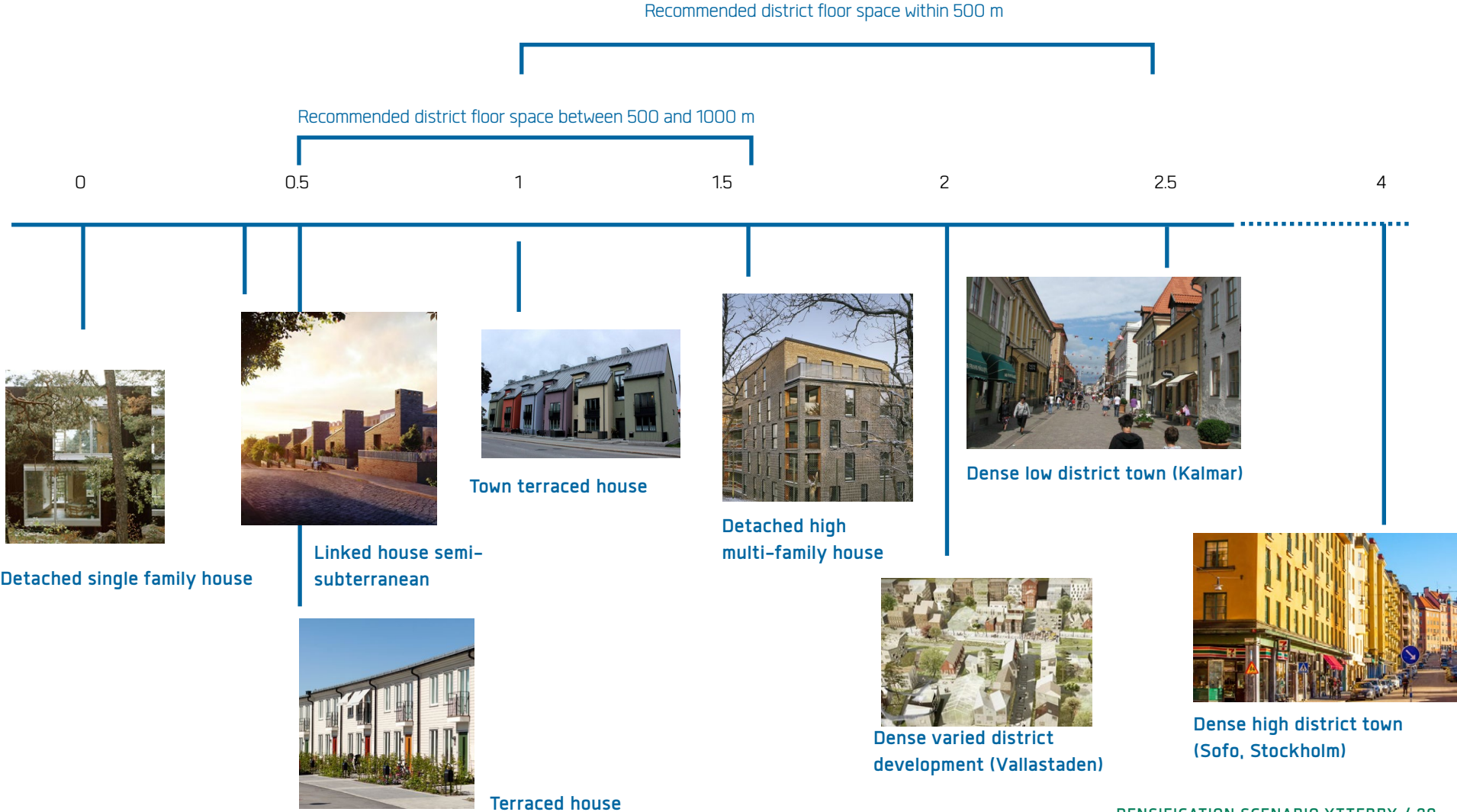
**Present: 0.08\*\***

**With densification scenario: 0.12-0.21** (plot floor space index 0.25-1.0)

\* Building area x 3 (average three floors) / land area of whole area

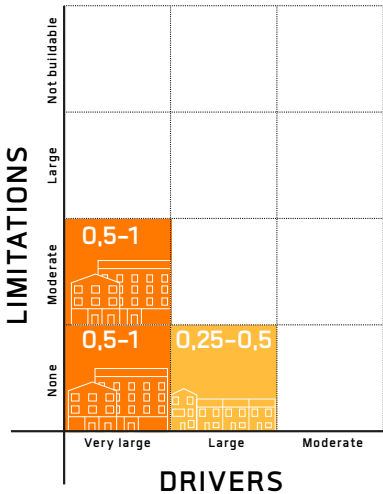
\*\* Building area x 3 (average three floors) / land area of whole area

# EXAMPLES OF HOUSE REFERENCES



# RESIDENTIAL POTENTIAL IN DENSIFICATION SCENARIO

A total densification potential of around 4,000 residences can be estimated within 1 km of the station based on the development areas and chosen plot floor space index in the densification scenario.



SPAN OF PLOT FLOOR SPACE IN DENSIFICATION SCENARIO

## RESIDENTIAL POTENTIAL IN DENSIFICATION SCENARIO

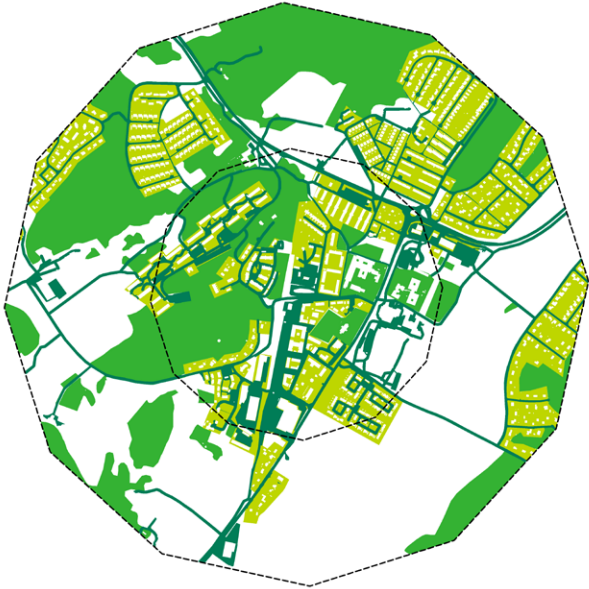
Potential of 4,000 additional residences within 1 km of Ytterby station is given here based on the total GFA (floor area) in the densification scenario and the deduction for other office floor area and public services.

# URBAN QUALITY IN DENSIFICATION SCENARIO PRESENT LAND USE

Urban qualities for residences, offices and trade have been mapped within the Gothenburg region with the Värdeskapande stadsutveckling (Value-creating Urban Development), Gothenburg City, GR et al 2016. The result has been based on the market price per sq.m. but also queuing time for rental property and the residents' own satisfaction with their district with regard to residences. The most important urban qualities to get people to thrive where they live is to make it available, dense and recreative.

Since the densification scenario means a higher density within close proximity to the station while reserving sufficient area for public spaces, the densification scenario provides very good conditions for an increased urban quality in Ytterby. To further increase its attractiveness on the residential market in accordance with the result from the urban quality study, new developments should contribute to giving more streets entrances turned inwards and districts designed with clear courtyards.

In order to create sufficient grounds for an attractive offering of services, it is also essential for the municipality to attract more workplaces to areas close to the station. Workplaces are generally more significant than residences since the workers to a higher degree populate the area during the day. This is probably the biggest challenge to continued work with creating a sustainable and attractive station community.



TODAY



DENSIFICATION SCENARIO

## LAND USE

### LAND USE TODAY

- Developed land 23%
- Public space zone 27%
- Street zone 13%
- Other areas 37%

### GUIDELINES FOR LAND USE

- Developed land 30-40%
- Public space zone at least 15%
- Street zone 20-30%
- Other areas max. 10%

### DENSIFICATION SCENARIO

- Developed land 40%
- Public space zone 15%
- Street zone 18%
- Other areas 33%



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