Annex 16

LERUM
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SP

lerum fjärrvärme

TRAFIKVERKET

Action A1. Analysis of suitable site location

Reports and surveys:

- on favourable sites for the facility
- on locality with good storage capacity
- on terrain conditions
- of land ownership
- on technical and financial evaluation

Life

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Innehåll

1 Action A.1

1.1 Objective

The objective of Action A.1 is to analyse and finally choose the most suitable location for the noise barrier with sun renewable energy production facility in Lerum.

1.2 Favourable sites for the facility

The noise situation has been investigated in a noise mapping made by the municipality of Lerum in 2003. Based on the noise mapping, three areas close to the motorway and/or the railway, with high noise levels have been chosen to be further investigated. The sites are evaluated and the most suitable area will be further and more thoroughly investigated to be the area for the noise barrier with solar renewable energy production.

For these three areas the previous noise study has been used in order to determine approximate height and length on the noise barrier, to protect as many properties as possible.

The sun condition in each area has first been assessed briefly by using maps. When the total area of the noise barrier has been decided, the estimated energy production has been set.

The proximity to the district heating system in each area has been assessed by using maps.

The terrain conditions in each area have been assessed by using maps and by field studies.

Any restrictions in each area, such as local plan regulations, proximity to high-voltage installations, wind- and snow load, air pressure from passing trains has been investigated by reviewing current regulations related to each sector.

The land owners concerned in each area have been identified by using the property owning records of the municipality of Lerum.

Finally the three areas have been valued from a summary financial and technical perspective in order to decide the definite location for the facility.

2 Restrictions

2.1 Safety distances

From an electrical point of view, the distance between the noise barriers and high-voltage parts must be at least 2.75 metre. The minimum distance to the aerial line pole must be at least 1 metre, in order to facilitate operation adjacent to the aerial pole.

High voltage lines normally are 5 ± 0.5 metres from the top of the rail.

The noise barrier crest should have a shape, which prevent that someone can stand on the barrier's crest. It should also be constructed to make it difficult to climb on the barrier.

To avoid the need of protective grounded connections, cover plates and etc. on the noise barrier crest should be avoided. Requirements for protective grounded connections: see BVF 510.

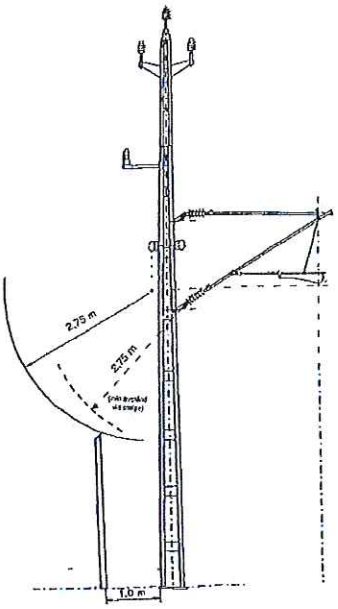


Figure 1. Placing of noise barrier

When elongated obstacles longer than15 m the regulations in section N3.5 of BVF 586.20 apply, this means that the screen can't be placed closer than 3.5 m from the nearest rail.

At a road construction site, the safety zone width shall be adapted to the prescribed speed. The safety zone width at roadwork is dimensioned as follows:

- Speed up to 50 km/h: at least 3 m,
- 60 km/h: at least 6 m wide,
- 70 km/h: at least 7 m wide,
- 80 km/h: at least 8 m wide,
- 90 km/h: at least 9 m wide,
- 100 km/h: at least 10 m wide,
- 110 km/h: at least 11 m wide,
- 120 km/h: at least 12 m wide.

2.2 Wind load

Regarding to safety class, loads, load combinations, load factors and resistance refer to Eurocodes. In the Eurocodes the e.g. wind load and the load of squirting snow from snow ploughing is determined. Load combinations and deflection requirements are set out in the Swedish Transport Administration TRVK Bro.

Wind load is determined by the following rules. Characteristic wind load W perpendicular to a surface is determined by the formula $W = m \cdot q \cdot A$, where m is the form factor, q is the wind speed pressure, and A is the projected area of the object. Wind velocity pressure is dependent on unfavourable terrain.

2.2.1 Wind load according to Eurocode 1

Wind load on the noise barriers can be calculated according to EN 1991-1-4 Eurocode 1: Loads on grid system - Part 1-4: General loads - Wind loads. The characteristic wind load is calculated from:

- reference wind speed due to geographical location
- an exposure factor that depends on the surrounding terrain
- Form factors for glazing.

Wind load is considered as static loads, and is classified as a variable bound load.

Terrain types:

- 0 is the sea or coastal area
- I is lake or flat area with small obstacles
- II is the area with low vegetation and occasional obstacles (buildings)
- III is the area with vegetation or buildings (villages, suburbs, forests)
- IV area largely populated with medium height >15 metres

Noise barriers along the railway shall be designed for both wind load according to EN 1991-1-4 and aerodynamic load of the train in accordance with EN 1991-2.

2.2.2 Wind speed and wind pressure

For Sweden, the reference wind speed is 21-26 m/s, depending on geographical location. The highest values are in the far south and in the mountains, and the lowest in the inner north. Wind pressure is constant up to 5 m height in terrain type III and up to 2 m height in terrain type II. Characteristic wind pressure for terrain III at different reference wind velocity are shown in Table 2. For other types of terrain, the following conversion factors: 1.20 for terrain type I (up to 1 m), 1.11 for terrain type II (up to 2 m) and 0.92 for the terrain type IV (up to 10m).

Reference wind speed (m/s)	Characteristic wind pressure (kN/m^2)
21	0,35
22	0,39
23	0,42
24	0,46
25	0,50
26	0,54

Table 1. Characteristic wind pressure for the type III terrain

2.2.3 Form Factor

According to EN 1991-1-4 the barrier is divided in wind load zones A to D according to the figure. In Zone D, at a greater distance from the barrier end than 4 x barrier height, the form factor of 1.2. In the zones A-C the form factor is increased, as shown in the figure. Barriers that ends with return corners or that have large openings may have slightly lower values. The lengths of the zones for different barrier heights are shown in chart 1.

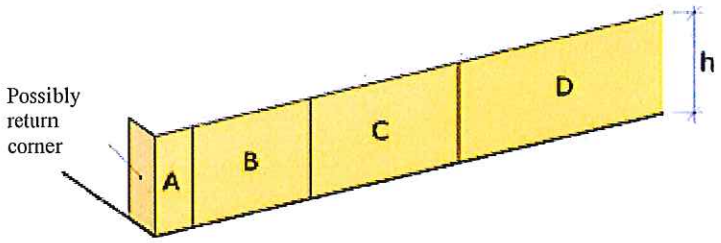
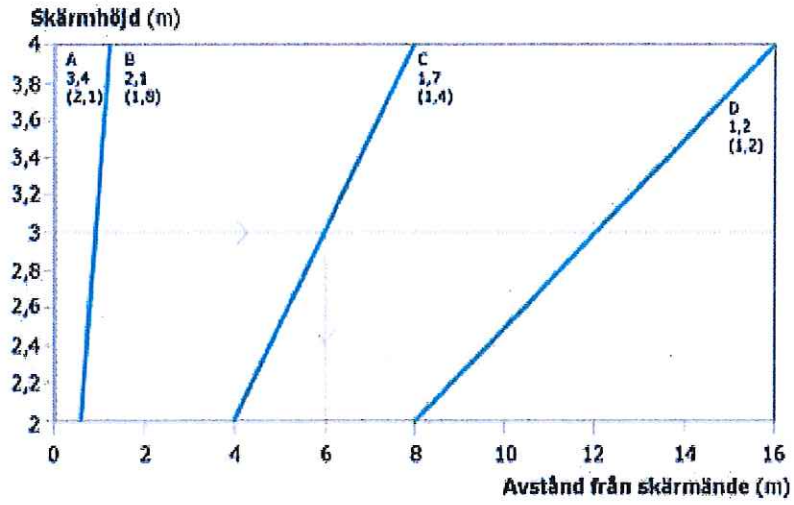


Figure 2. The noise barrier's breakdown into wind load zones

Barrier height (m)



Distance from barrier end (m)

Chart 1. Length and form factor for the different load zones at the end of the noise barrier. Values in parentheses refer to a noise barrier with return corners with the length ≥ height.

2.3 Snow load and snow removal

The snow load dimensioned can be calculated according to EN 1991-1-3 Eurocode 1: Actions on structures - Part 1-3: General actions - Snow loads.

When removing snow, the snow is thrown against the screen, and a horizontal load on the noise barrier occurs when the distance to the road is small. The snow load from snow removal can become dimensioned for the noise barrier, but usually not for the poles and foundations. The poles and foundations are most affected if the screen is high and the fundaments are placed low in relation to the road surface. The load doesn't include snow pressed against the barrier. The load size is specified in EN 1794-1, and is due to the barrier distance to the road and the speed of the plough vehicle. The load is set to 5-15 kN over an area of 2x2 m, with resultant force 1.5 m above the ground.

Due to squirting snow from snow ploughing a load in the direction with a characteristic value of 15 kN/m^2 is assumed. It is assumed to act horizontally within 6 m from the roadside and up to 2.5 m above the roadway on an area <0.5 m^2.

Load from snow removal is not assumed to act simultaneously with the wind load. If the distance from the ploughed area to the barrier is larger than 7 m, the wind load is usually greater than the snow load.

2.4 Other loads

2.4.1 Inflation pressure from passing vehicles

At high speeds and small distance between the passing vehicle and the barrier, the dynamic air pressure should be taken into account. The load size is specified in EN

1794-1. E.g. the dynamic pressure from vehicular traffic in the open is specified to 0.8 kN/m^2 at vehicle speeds above 120 km/h and the distance 3 meters between the vehicles and the barrier. The inflation pressure from the vehicle doesn't need to be combined with the wind load.

Aerodynamic* load from train with a speed of 250 km/h.

Distance from track centre (m)	Aerodynamic load from trains (kN/m^2)
2.3	1.2
3.0	0.8
4.5	0.4
6.3	0.25

Table 2. Aerodynamic loads from trains.

* Aerodynamic loads from passing trains are mainly due to the speed of the train, design, structural the grid system shape, the distance between the train and the grid system.

2.4.2 Self weight

At the design with respect to self weight the current values of own weight, strength, stiffness and other factors, with regard to the climatic class and safety shall be used.

Barrier elements are dimensioned according to EN 1794-1, in the ultimate limit state with a partial factor of 1.5. For self weight in combination with wind load partial factors 1.35 for self-weight shall be used and 1.5 for wind load and other loads.

2.5 Deformation requirement

The foundation rotation or displacement shall not be included in the calculations of deformations.

The maximum elastic deflection for structural elements may for vertical screens loaded with dimensioning wind load in serviceability limit state according SS-EN 1794-1 not exceed the element's length / 100 for barrier with a height up to 3 m and maximum length / 150 for a barrier with a height more than 4.5 m.

Tilted barriers are dimensioned according to SS-EN 1794-1 for self weight and snow load in combination with wind load. The most accepted elastic deflection is supporting member's length / 300.

After a load of 1.5 times the design wind load, the remaining deflection may not exceed the element's length / 500. Nor should other damages have occurred on the barrier or on fixings.

For acoustic barriers carried by another construction, the corresponding requirements for permanent deformation apply. For the elastic deflection a maximum of 50 mm or element length / 40 for vertical screens with lengths up to 5 m apply. For tilted barriers element length / 200 apply.

3 Area: Lerum

Noise barrier for the motorway E20 and the railway the main western line, from Aspedalen to Takåsen
Length: Approximately 400 m,
Height: Approximately. 2.5 m
Area: Approximately 1 000 m^2

3.1 Noise

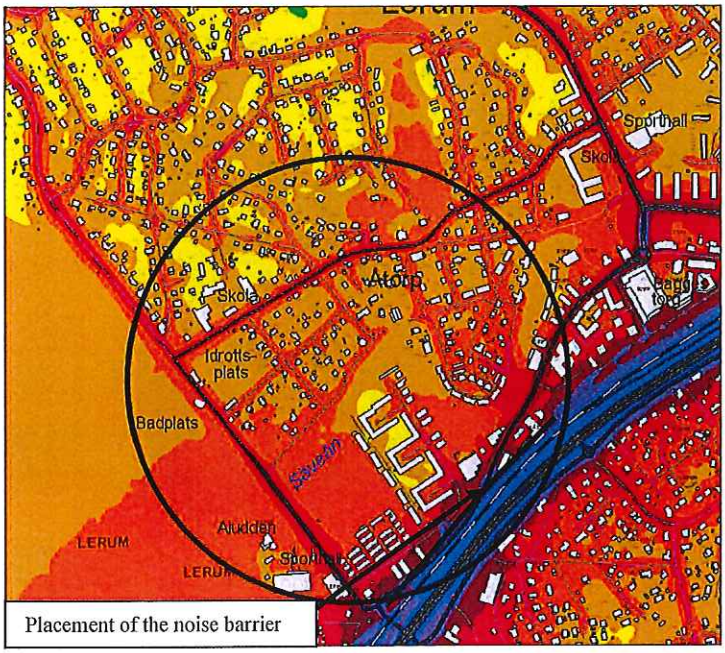


Figure3. Noise map for the Lerum area

The area has priority # 2 in the municipality of Lerum thematic supplement on noise. In the area there are about 250 properties and approximately 1,100 residents, as well as one elementary school and four preschools exposed to noise. The total number of people exposed to noise farther away is greater than 1,100, since the noise disturbance reaches farther. The noise barrier will also reduce noise levels over a greater distance.

3.2 Sun conditions

The sun conditions in the area are very good. The noise barrier is planned to be placed in the east-west direction with solar panels facing south. There is basically no shading in the area. The output also depends on at what temperature the energy will be used. Calculations on solar energy production are performed by partner SP during October and November 2012. In this early stage of the project calculations of sun energy production are as below.

If the project can use heat at 60 degrees the output can be about 400.000 kWh per year. At 75 degrees the output will be about 300.000 kWh per year.

Later in the project more specific figures of sun energy production will be presented when adaption of solar panels are determined, please see Action B2.

3.3 Proximity to the district heating system

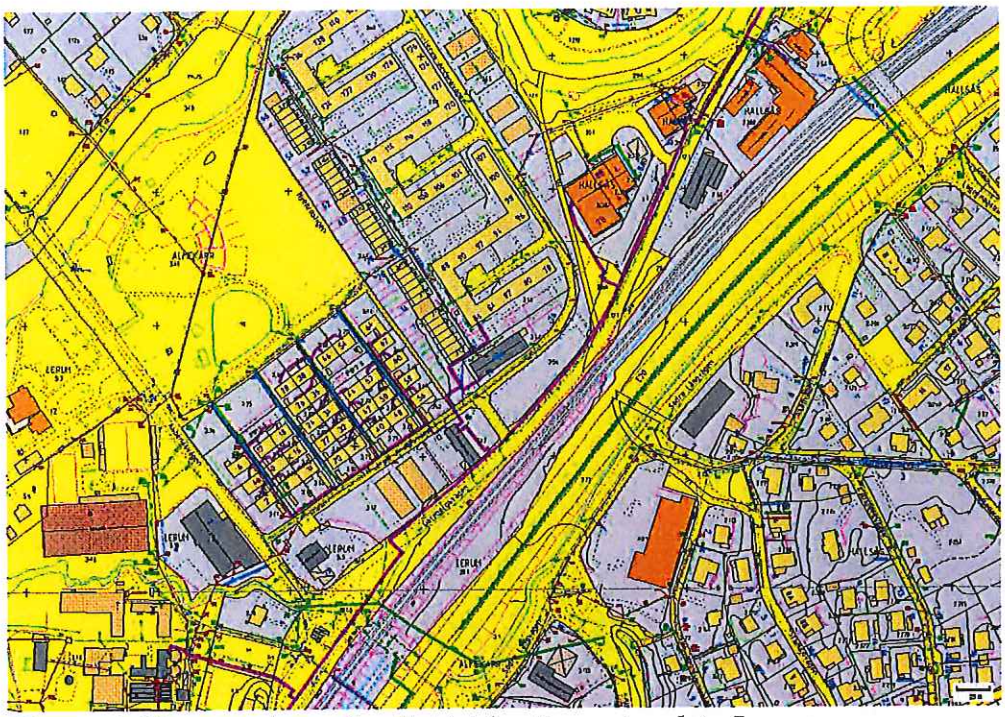


Figure 4. The map shows the district heating network in Lerum

The proximity to the district heating system is very good in the area. There are district heating pipes in direct adjacent to the area, 10-30 meters from the planned placement of the noise barrier. The district heating system here is equipped with an accumulator tank, which is of importance to be able to better utilize the energy, hence the heat of the day can be received and stored. The accumulator tank is owned by partner Lerum Fjärrvärme which is beneficial to the project.

3.4 Terrain conditions

Both the motorway E20 and the railway, the main western line is placed higher than the residential area, which means that the noise can spread far. The noise barrier should be placed as close to the rail as possible, in some places there are steep slopes and proximity to the local road.

Figure 5. Picture of the Lerum area

On the greater part of the distance there's post-glacial sand / coarse sand, in the eastern part there's sandy moraine. On the greater part of the distance there's low boulder and in the eastern part there's normal blockiness. Swell is not specified in the area.

3.5 Land owners and local plan regulations

Property	Address	Owner:	Local plan	Comment
Hallsås 2:58	Göteborgsvägen 1	LOE Fastighets AB	LD113	The stretch along the railway's point dotted land. Point dotted land must not be built on, not even with noise barrier.
Hallsås 2:202	Göteborgsvägen 3	AVANTI Förvaltnings KB	LS 26	The stretch along the railway's point dotted land. Point dotted land must not be built on, not even with noise barrier.
Hallsås 2:54	Göteborgsvägen 7	Kenneth Henriksson	LS 26	Park or planting. The area must not be built on, not even with noise barrier.
Lerum 20:4		Lerums kommun	LS 26	Park or planting. The area must not be built on, not even with noise barrier.
Almekärr 3:40		Lerums kommun	Outside local plan	
Hallsås 17:1		Lerums kommun		Railway purpose
Lerum 20:1		Trafikverket		Railway purpose

Table 3. Land owners and local plan regulations in Lerum

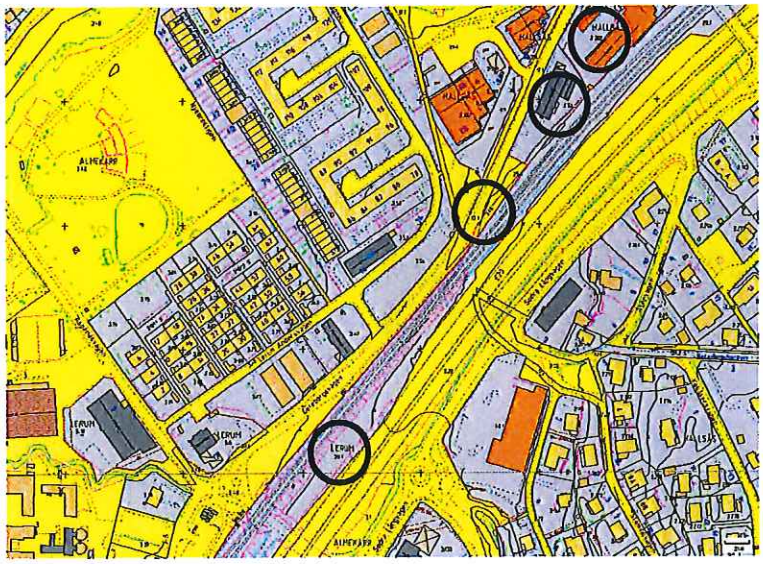


Figure 6. The map shows the properties concerned in Lerum

Properties highlighted in yellow are owned by the municipality of Lerum.

The municipality of Lerum and the Swedish Transport Administration owns most of the land in the area. In the north-east part of the area there are some properties owned by private property owners.

3.6 Contact with landowners

Contact with landowners has been made to examine possibility to get access to land behind the commercial buildings in the north-east part of the area.

4 Area: Floda (E20)

Noise barrier for E20, from Floda Allé to Öhrnevinges väg
Length: Approximately 250 m,
Height: Approximately 2.5 m,
Area: Approximately 625 m^2

4.1 Noise

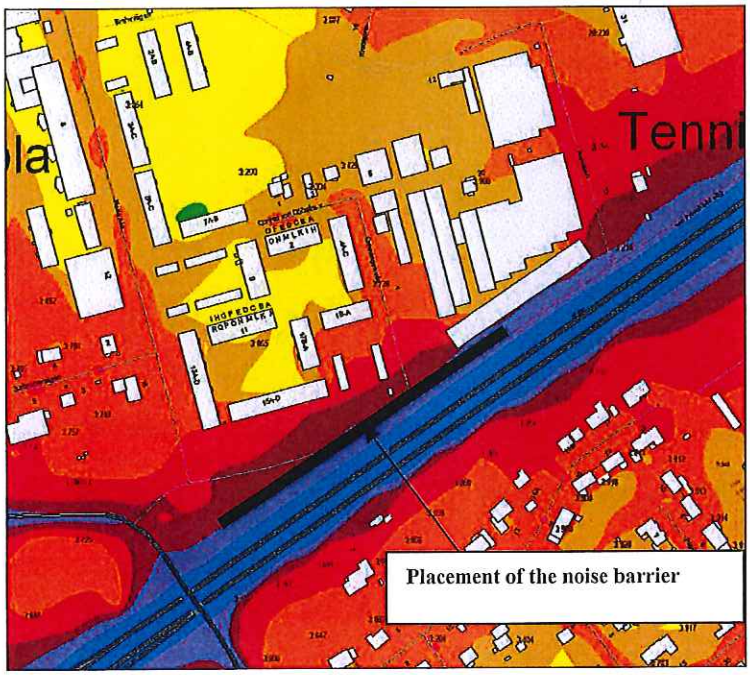


Figure 7. Noise map for the Floda (E20) area

The area is priority # 16 in the municipality of Lerum thematic supplement on noise. In the area there are some 30 properties and approximately 90 residents, exposed to noise levels above the guideline value.

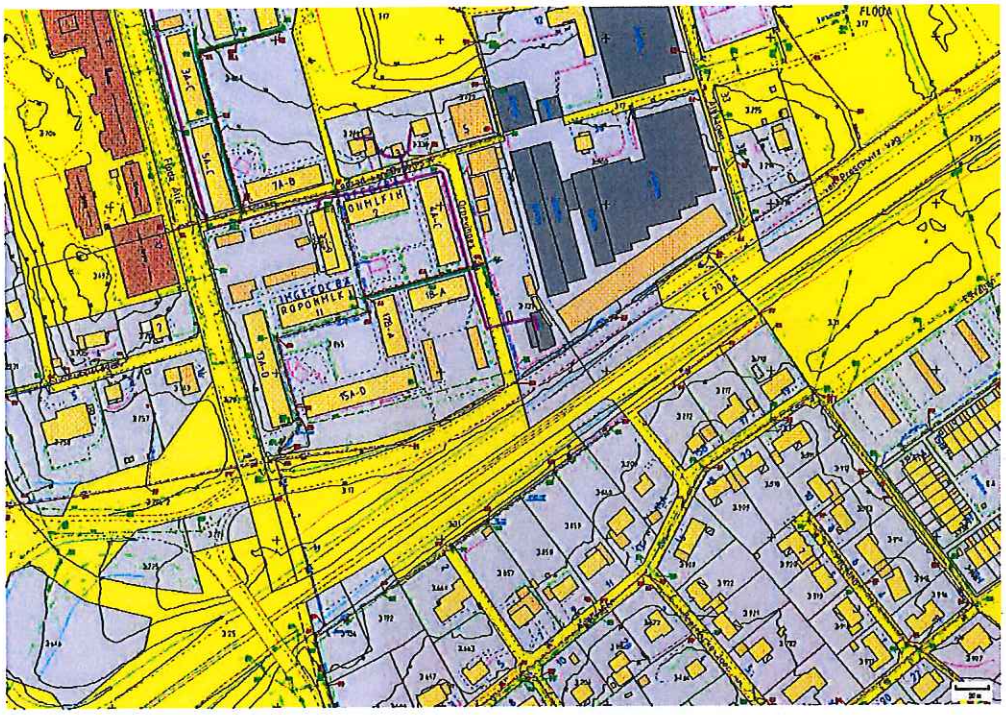
4.2 Sun conditions

The sun conditions in the area are very good. The noise barrier is planned to be placed in the east-west direction with solar panels facing south. There is basically no shading in the area. The output also depends on at what temperature the energy will be used. Calculations on solar energy production are performed by partner SP during October and November 2012. In this early stage of the project calculations of sun energy production are as below.

If the project can use heat at 60 degrees the output can be about 250.000 kWh per year. At 75 degrees the output will be about 200.000 kWh per year.

Later in the project more specific figures of sun energy production will be presented when adaption of solar panels are determined, please see Action B2.

4.3 Proximity to the district heating system



District heating system

Figure 8. The map shows the district heating network in Floda (E20)

The proximity to the district heating system is very good. There's a district heating central close to the area, within 50 meters from the planned placement of the noise barrier. In this district heating system there are no accumulator tank, which means that it's not possible to store the heat of the day

4.4 Terrain conditions

The motorway E20 is in an intersection, which means that the noise does not spread far into the area but is shielded to some extent by the difference in height. The residential area is relatively flat. Noise barriers should be placed as close as possible to the E20. In some places the local road is close.

Figure 9. Picture of the Floda (E20) area

On the half part to the west the ground contains of postglacial gravel and the half part to the east the ground contains of glacial clay. The blockiness in the area is low, on other soil types than moraine. Swell is not specified in the area.

4.5 Land owners and local plan regulations

Property	Adress	Owner	Local plan	Comment
Floda 3:739		Åke Olsson i Floda AB	SB 18	Roadtraffic purpose and likely
Floda 3:17		Lerums kommun	SB 18	Roadtraffic purpose and likely

Table 4. Land owners and local plan regulations in Floda (E20)

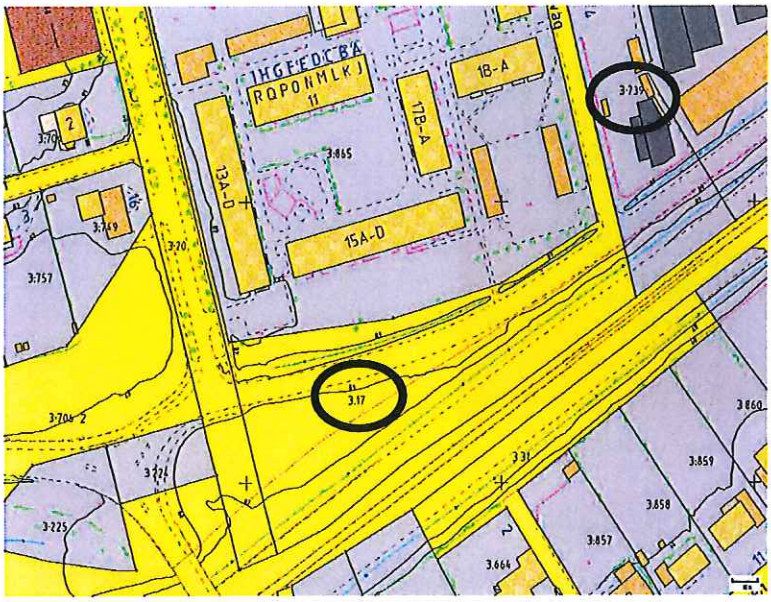


Figure 10. The map shows the properties concerned in Floda (E20)

Properties highlighted in yellow are owned by the municipality of Lerum.

The municipality of Lerum and the Swedish Transport Administration owns most of the land in the area. In the north-east part of the area there are one property owned by a private property owner.

4.6 Contact with landowners

If this area is chosen contact with landowner will be made to examine the possibility to get access to the land in the north-east part of the area.

5 Area: Floda (VSB)

Noisebarrier for the Western main line, from Uddaredsvägen to Floda station
Length: Approximately 200 m
Height: Approximately 2,5 m
Area: Approximately 500 m^2

5.1 Noise

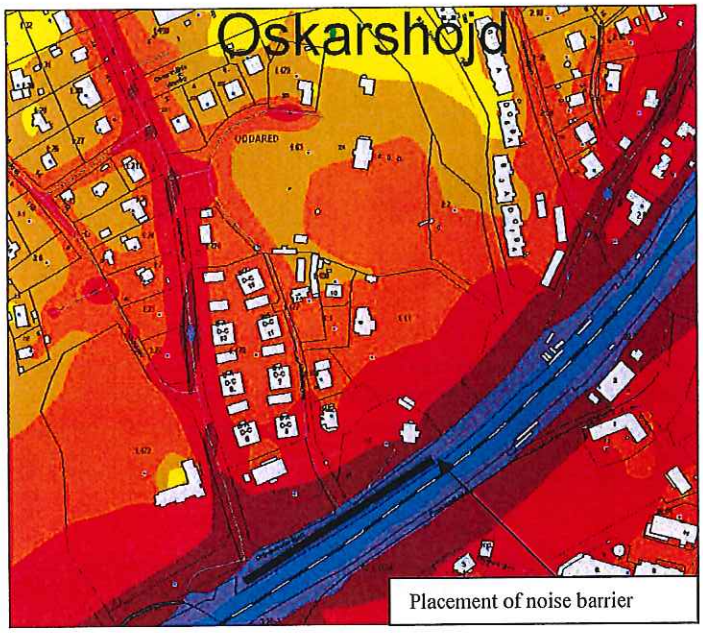


Figure 11. Noise map for the area Floda (VSB)

The area is priority # 4 in the municipality of Lerum thematic supplement on noise. The area has about 15 properties and approximately 90 residents, exposed to noise exposed to noise levels above the guideline value.

5.2 Sun conditions

The sun conditions in the area are very good. The noise barrier is planned to be placed in the east-west direction with solar panels facing south. There is basically no shading in the area. The output also depends on at what temperature the energy will be used. Calculations on solar energy production are performed by partner SP during October and November 2012. In this early stage of the project calculations of sun energy production are as below.

If the project can use heat at 60 degrees the output can be about 200.000 kWh per year. At 75 degrees the output will be about 150.000 kWh per year.

Later in the project more specific figures of sun energy production will be presented when adaption of solar panels are determined, please see Action B2.

5.3 Proximity to the district heating system

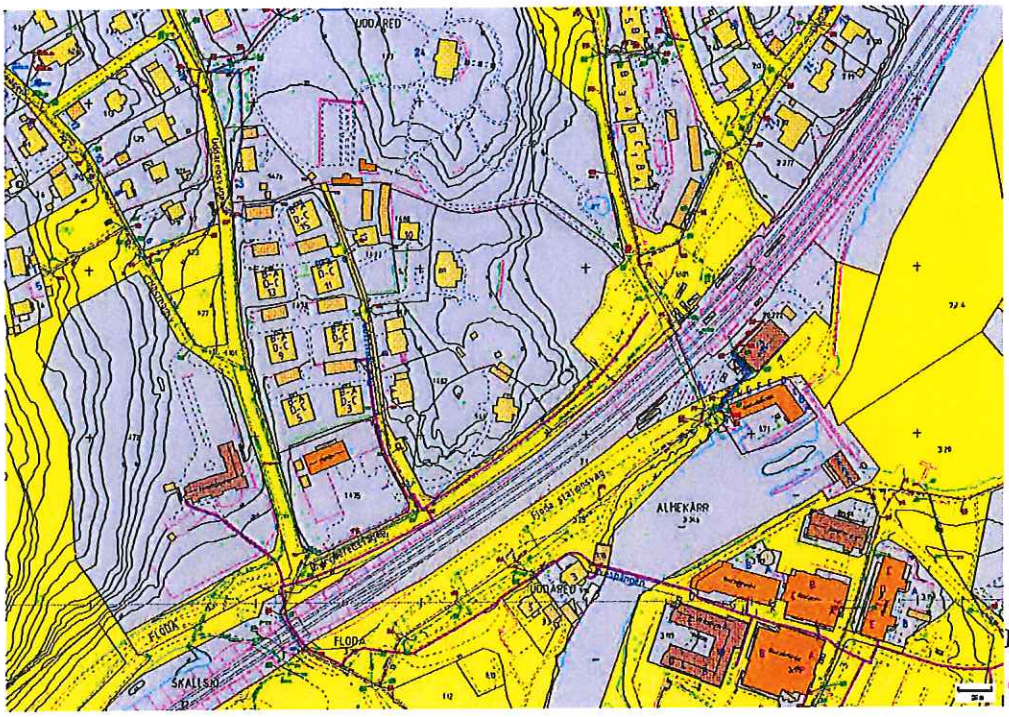
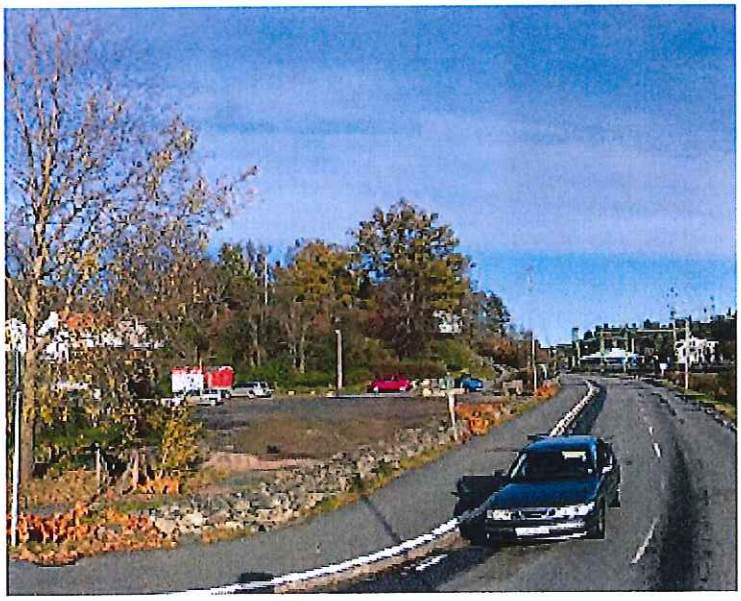


Figure 12. The map shows the district heating network in Floda (VSB)

The proximity to the district heating system is very good in the area. There are district heating pipes in direct adjacent to the area, 5-30 meters from the planned placement of the noise barrier. In this district heating system there's no accumulator tank, which means that it's not possible to store the heat of the day.

5.4 Terrain conditions



The land slopes upward from road and railway the main western line, against residential buildings. The land is flat along the railway.

Figure 13. Picture of the Floda (VSB) area

Ground conditions in the area are glacial clay. The blockiness in the area is low, on other soil types than moraine. Swell is not specified in the area.

5.5 Land owners and local plan regulations

Property	Adress	Owner	Local plan	Comment
Uddared 1:101		Lerums kommun	SD 330 + SB 29	Area for park or planting outside railroad area.
Skallsjö 7:1		Trafikverket	SD 330 + SB 1	Area for railroad. Area for park or planting outside railroad area.

Table 5. Land owners and local plan regulations in area Floda VSB

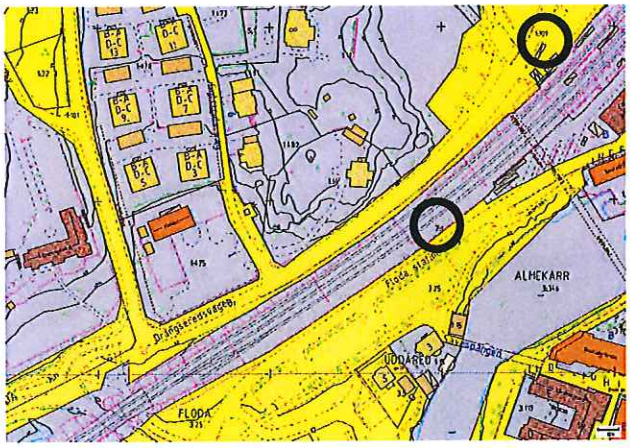


Figure 14. The map shows the properties concerned in Floda (VSB)

Properties highlighted in yellow are owned by the municipality of Lerum.

The municipality of Lerum and the Swedish Transport Administration owns the properties concerned.

5.6 Contact with landowners

There are no other landowners except the municipality of Lerum and the Swedish Transport Administration in the suggested placement of the noise barrier.

6 Evaluation of the areas studied

6.1 Technical evaluation

Three suitable sites for the facility have been identified. Technically, the noise barrier with sun energy production can be built at all these locations. The sun conditions and terrain conditions are equivalent at all three places. The site in Lerum however has many other advantages compared to the two sites in Floda. In Lerum:

- There are two noise sources, both the E20 and the main Western line. This gives a greater impact of the noise disturbance in the area.
- There are more people exposed to noise and thus more people can take advantage of the noise barrier.
- There's an accumulator tank at the district heating plant, which increases the ability to receive and store the heat of the day.
- The district heating network is very close to the location of the facility.
- A larger facility can be built, because the stretch is longer, this provides a larger amount of renewable energy to the district heating system.

6.2 Financial evaluation

In Lerum there are approximately 1,100 residents exposed to noise. In Floda (E20) and Floda (VSB) there are approximately 90 residents exposed to noise at each site.

The socio-economic impact is greater in Lerum than in Floda, since there are a greater number of people exposed to noise in Lerum and thus more people will get benefit of a noise barrier in Lerum. This means that the reduction of the socio-economic costs of noise becomes larger if the facility is built in Lerum.

Since there are more properties exposed to noise in Lerum the impact on property values will be larger here when the noise levels get lower.

A facility in Lerum is possible to be made larger than the ones in Floda, which means;

- A larger amount of renewable energy can be produced.
- A larger amount of CO_2 emissions can be saved

7 Final decision on location for the facility

The Lerum site has many advantages compared to the two sites in Floda. Above all the noise disturbance is larger and the number of people exposed to noise is greater in Lerum. A solar thermal facility in Lerum can also be made larger than in the other sites and thus produce more renewable energy. In Lerum there's an accumulator tank, which greatly facilitates the implementation, hence the energy can be stored and the heat of the day be taken care of, this isn't possible in Floda.

A measure to reduce noise in Lerum will have a greater impact, both in terms of reduced costs of noise nuisance and in terms of increased property value since there are more properties and residents.

The location of the facility is decided to the site in Lerum.