Measure priority study

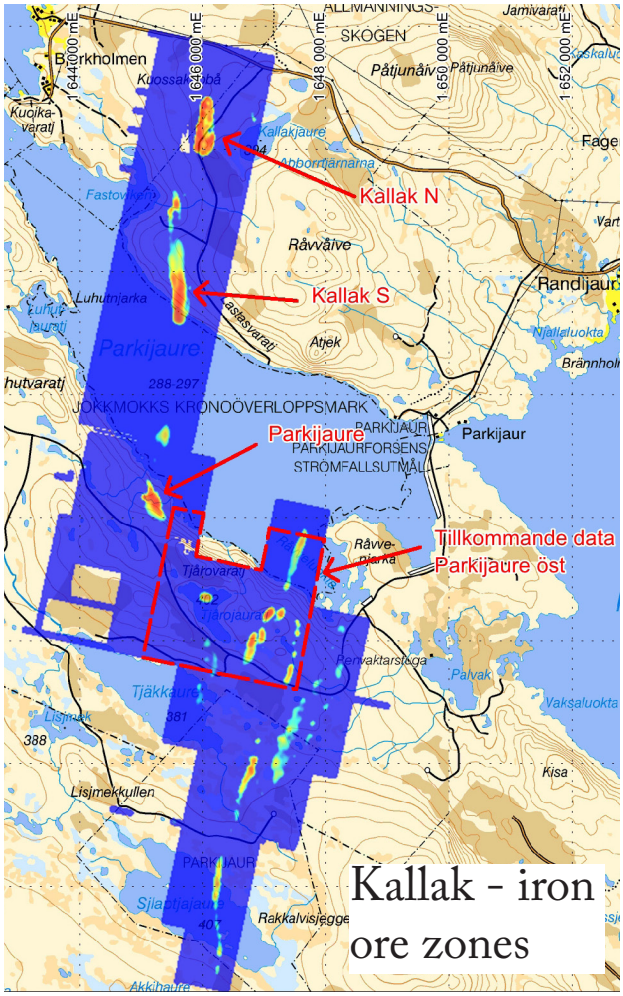
Ore Transports between the Kallak Mine and the Malmbanan line

2012-12-20

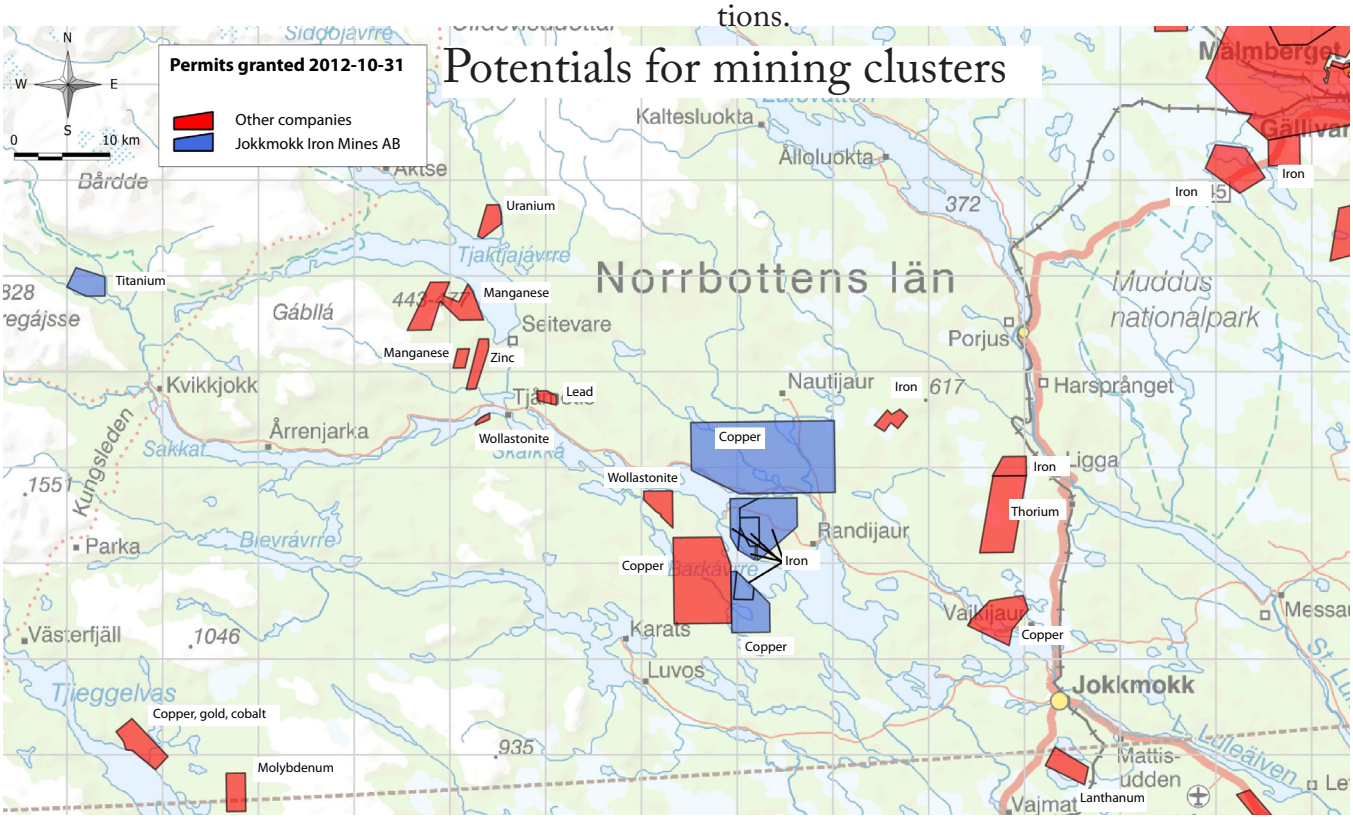
Preface

In the area around Jokkmokk there are many iron ore deposits of interest that have potentials to be developed into a mining cluster. Kallak is one of them, a large ore deposit with a good concentration of iron and very low levels of sulphur, phosphorus and other disturbing elements for production and environment. The deposit has been known since the 1940s, when SGU (Geological Survey of Sweden) conducted ground surveys, drilling and shallow sampling for further studies. Thereafter, the interest for the deposit has been low up until a couple of years ago. The increased demand on iron ore after the turn of the century incentivised the British company Beowulf Mining Plc. to re-evaluate the possibility to develop the deposit into a mine. From then on, work on drilling, analysis and investigations have been performed by Beowulf's Swedish subsidiary Jokkmokk Iron Mines AB (JIMAB).

85% of the EUs need for iron ore is currently imported from outside of Europe, the interest to increase self-sufficiency is therefore great. Sweden, and in particular the inland of Norrland is dependant on the availability of jobs. Mining in Kallak could therefore come to meet local, national and European needs.



A large part of the total production cost is transportation of the iron concentrate. Finding cost effective transport solutions with limited effects on the climate, environment and existing land use, is therefore important. This report is the first step in describing the existing options.



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0 Summary

Northern Sweden is EU's most important mining region, responsible, amongst other things, for around 90 % of the EUs production of iron ore.

Jokkmokk Iron Mines AB is investigating the possibility of opening a new iron mine in Kallak, about 40 km west-northwest of Jokkmokk. The deposit is situated about 35 km southwest of Porjus and about 90 km southwest of Gällivare, as the crow flies. By road these distances are presently about 75 and 125 km.

Substantial measures need to be taken within the transport system to cope with the transports resulting from the mining operations.

Planning and implementation need to take place as soon as possible with high priority, to enable a functioning rail transport solution in time for the start of mining.

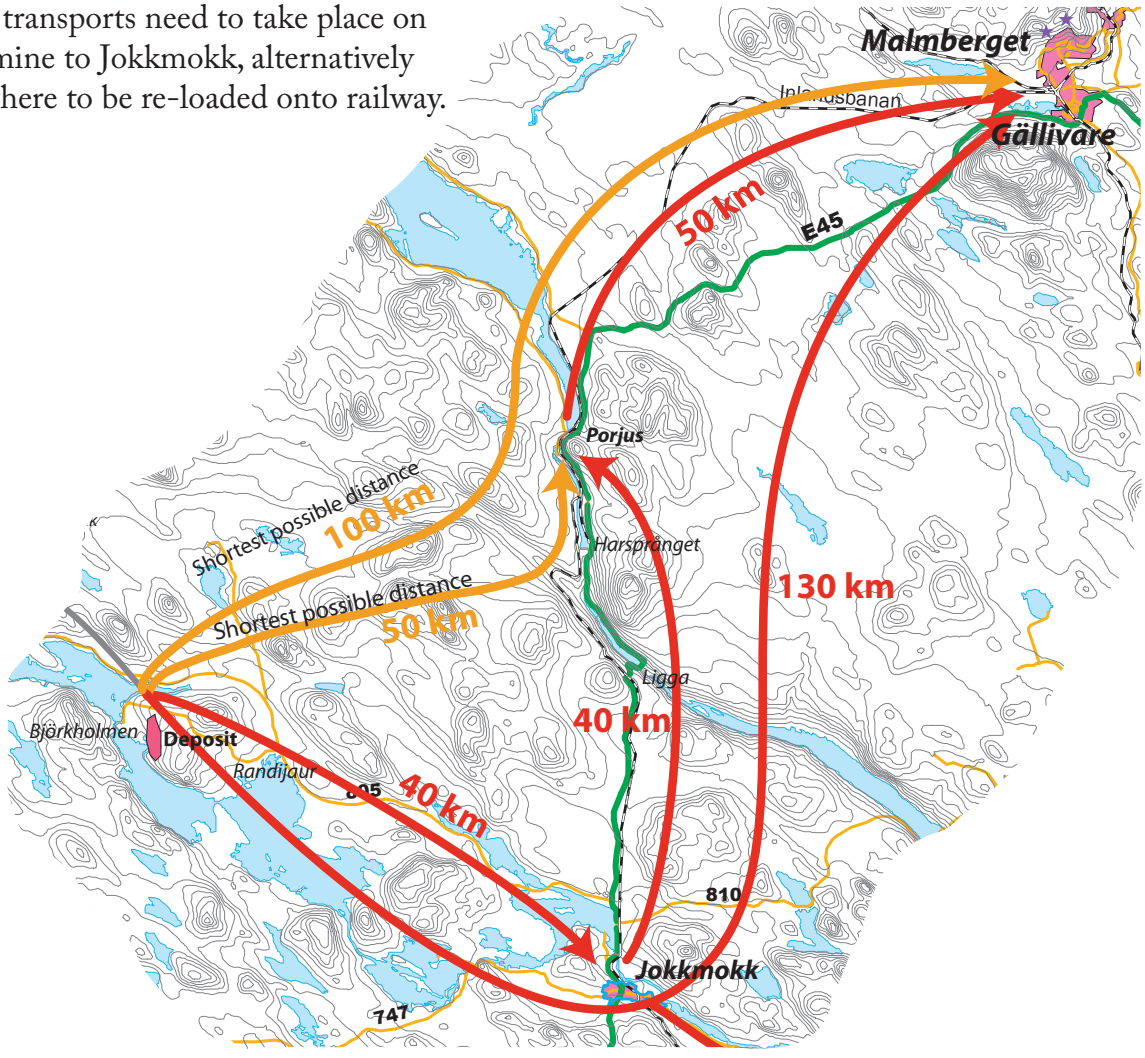
Otherwise, the transports need to take place on road from the mine to Jokkmokk, alternatively Gällivare, and there to be re-loaded onto railway.

The purpose of this study is to, at an early stage, clarify possible alternatives. Thus, enabling further in depth studies and dialog with Trafikverket (the Swedish Transport Administration) as well as concerned ministries.

The planned mine will generate 4.2 million tonnes of concentrate/year, which is the mine`s dominating transport volume.

The mine will require input gods, mainly fuel and substances used in the making of explosives. Moreover lining material, reagent, etc. is required.

In addition to this there will be passenger transport to and from the mine for about 400 full time employees as well as passenger and goods transport for contractors.



Current and potential future distances of strategic routes

Close to the mine, there are a few small villages with about 100 inhabitants in total. The municipality of Jokkmokk has three urban concentrations:

- Jokkmokk township with about 3000 inhabitants about 400 km east-southeast of Kallak
- Vuollerim township with about 1000 inhabitants (including surrounding villages) just over 80 km from Kallak
- Porjus township with close to 400 Inhabitants about 80 km by road from Kallak, but only 35 km as the crow flies.

Gällivare, situated 90 km by road from Jokkmokk, has considerable access to contractors within and closely related to the mining industry and moreover, the town is the location of the county district hospital.

A large number of transport infrastructure solutions have been tested at an idea stage. However, the topography is making short transport solutions difficult.

The following alternative routes have been studied:

- UA1 GEN (Short), about 99 km Kallak-Gällivare
- UA1 VÄST (West), about 102 km Kallak-Gällivare
- UA1 MITT (Mid), about 117 km Kallak-Gällivare
- UA1 SYD (South), about 122 km Kallak-Gällivare
- UA 2: Lorry transport Kallak - the Inlandsbanan line
- UA 3: Lorry Kallak - Gällivare

The railway alternatives Kallak-Gällivare have relatively similar investment costs of about SEK 3.9-4.4 billion. The differences in cost are within the margin of error in this investigative stage.

The alternatives with lorry transport to existing railway terminal, require a considerably lower level of investment, but also lead to considerably lower social benefits. The cost of UA2 is about SEK 2.9 billion and UA3 about SEK 1.3 billion.

In UA2 and UA3, a new terminal for the extra reloading from lorry to rail, is included in the cost. The cost for the terminal is estimated to SEK 200 million.

The railway alternatives (all UA1) are the most socio-economically beneficial. UA1 Väst (West) means about SEK 1.4 billion more preferable result than UA3 and about SEK 0.7 billion more than UA2. The other UA1 variations give similar, although slightly inferior results than UA1 Väst (West). The result is further strengthened if the mine permits mining activity beyond 40 years.

All of the UA1 variations mean good goal fulfilment in terms of social and ecological sustainability. Please see evaluation matrix below. The overall assessment is therefore that UA1 is preferred. Deeper studies are needed to determine which variation is best.

In case the building of a new railway line takes too long, UA2 is an option with relatively good profitability. It is important with a quick process and to generate understanding and support from transport authorities and other agencies.

Some key issues need to be urgently handled:

- What is the cost of increasing axle load capacity of the Inlandsbanan line to permissible axle load (STAX) 30 tonnes? Advanced studies.
- How do the gradients at Stora Luleå Älv (Great Luleå River) affect investment measures and transportation costs?

Evaluation chart

	UA1 West	UA1 Short	UA1 Mid	UA1 South	UA2	UA3
Economics, the mine						
Economics, the society						
Ecological sustainability						
Social sustainability						
Rapid completion						
Risks						

1 Background

1.1 Large iron ore deposits in Jokkmokk municipality

Jokkmokk Iron Mines AB (JIMAB) is investigating the possibility of opening a new iron mine in Kallak, about 40 km west-northwest of Jokkmokk. The deposit is situated about 35 km southwest of Porjus and about 90 km southwest of Gällivare, as the crow flies. By road these distances are presently about 75 and 125 km.

The Kallak deposit is the largest presently known deposit of so called "quartz mixed iron ore" planned to be mined. With an estimated volume of 600 million tonnes, the mine will be able to produce over 10 million tonnes of iron ore annually. The ore is planned to be further processed to concentrate within the mining area. The resulting product to be transported to the port of Narvik or Luleå, will be about 4.2 million tonnes/year. The Kallak deposit is part of a larger ore field.

The very large volumes mean a comprehensive transport operation, which requires investigation of the transport infrastructure mainly for freight, but also for passenger transport.

Planning and implementation need to take place with high priority, to enable a functioning rail transport solution in time for the start of mining.

Otherwise, the transports need to take place on road from the mining facility to Jokkmokk, alternatively Gällivare, and there to be re-loaded onto railway.

The purpose of this study is to at an early stage clarify possible alternatives and their characteristics. Thus, enabling further in depth studies and dialog with the Swedish Transport Administration (Trafikverket) as well as concerned ministries.

1.2 The work process for the construction of mining operations

The decision to start a mine is preceded by several sub processes regarding permits for operations as well as investigations concerning profitability.

The held exploration permits must firstly be supplemented by an exploitation concession, which is issued by Bergstaten. The application for exploitation includes an EIA (Environmental Impact Assessment) focused on land use. After that an environmental permit is needed, issued by the Land and Environmental Court, which in cooperation with other authorities examine the project in accordance with Chapter 9 and 11 of the Swedish Environmental Code. This includes a detailed EIA, developed in an open process of consultation with concerned parties and the public. A third examination to determine if building permits for buildings included in the project can be granted, is made under the Planning and Building Act by the municipality. Additionally, the rules in the regulation of extractive waste, regulation of environmental quality, waste regulation, self-regulation, and the Heritage Conservation Act, etc. will need to be taken concidered by the company.

Alongside the application process techno-economic studies are carried out. These studies get progressively more detailed and in depth to assess the profitability of the project and serve as a basis for financing decisions.

The timeframe for implementation of the above mentioned investigations is estimated to take at least 4 years with 1 additional year for examination and decision. If decision is taken to start the mining operations, preparation and construction time is estimated to about 18 months. This period is characterized by considerable ground, construction and assembly work etc. and could require several hundred people in addition to the workforce estimated for general operation of the mine. Heavy transports will have to take place shortly after decision on investment, to get machinery on site.

1.3 Previously performed infrastructure planning

During 2012 planning has been on-going with meetings and contacts with for instance the Swedish Transport Administration (Trafikverket), Jokkmokk Municipality and The Inlandsbanan line AB.

The iron concentrate from the mine will mainly be exported out of Sweden and therefore needs to be transported to for continued transport by ship. Suitable ports are Narvik and Luleå.

In both cases the concentrate will be transported via Gällivare and onwards by rail on the Malmbanan line. It was found that if it would be necessary to build a new railroad or upgrade The Inlandsbanan line, that particular part of the transport infrastructure would be the most time critical to complete before the start of mining in 2018. It was therefore decided that a separate investigation is to be carried out for that part.

A parallel investigation of port alternatives is ongoing and will be intensified during next year. Advantages have been found in both port alternatives.

Port of Luleå

- Shorter transport by rail.
- Available capacity on the Malmbanan line.
- Good possibilities for construction of terminal in close connection with the deep port.
- Railway with axle load 30 tonnes is available to the terminal.
- Port of Narvik
- No specific regulations on fuel. (The sulphur directive for boat traffic in the Baltic Sea will increase the cost of sea freight by approximately 30 % from Swedish east coast ports)
- Shorter and faster shipping
- Possibility to use larger ships.
- No need for ice-classed vessels.

1.4 Related planning

Since the founding of the Inlandsbanan line AB the railway line has gradually developed. The northern most section, Jokkmokk-Gällivare, has the lowest standard.

The regional transport plan shows investments on speed increasing measures on the Malmbanan line between Luleå and Kiruna.

Efforts are being made on the road system between Svappavaara and the mines in Pajala municipality. The ore volumes are loaded on to railway in Svappavaara and transported to Narvik.

The Malmbanan line has high bearing capacity, but insufficient capacity in relation to the large volume of goods needed to be transported.

The infrastructure budget bill highlights the need for increased capacity on the line Kiruna - Narvik. More passing stations and double track or partial double track are needed.

The action plan for the Inlandsbanan line has identified needs for improvement for 1,8 billion SEK. 550 million of these consist of raising the bearing capacity to axle load 22.5 tonnes between Arvidsjaur and Gällivare.

1.5 Overall aim of the measures discussed in this study

The measures discussed in this study aim to enable a sustainable transport solution for the mining before the start of mining.

The goal is a solution that is both economically beneficial as well as environmentally and climatically appropriate.

Social sustainability is also important, which is why good commuting possibilities are essential.

2 Scope and time frame

2.1 Geographical scope

The geographical area covered in this infrastructure study includes the ore deposit in Kallak, Jokkmokk township, nearby Porjus and up until the Malmbanan line in Gällivare.

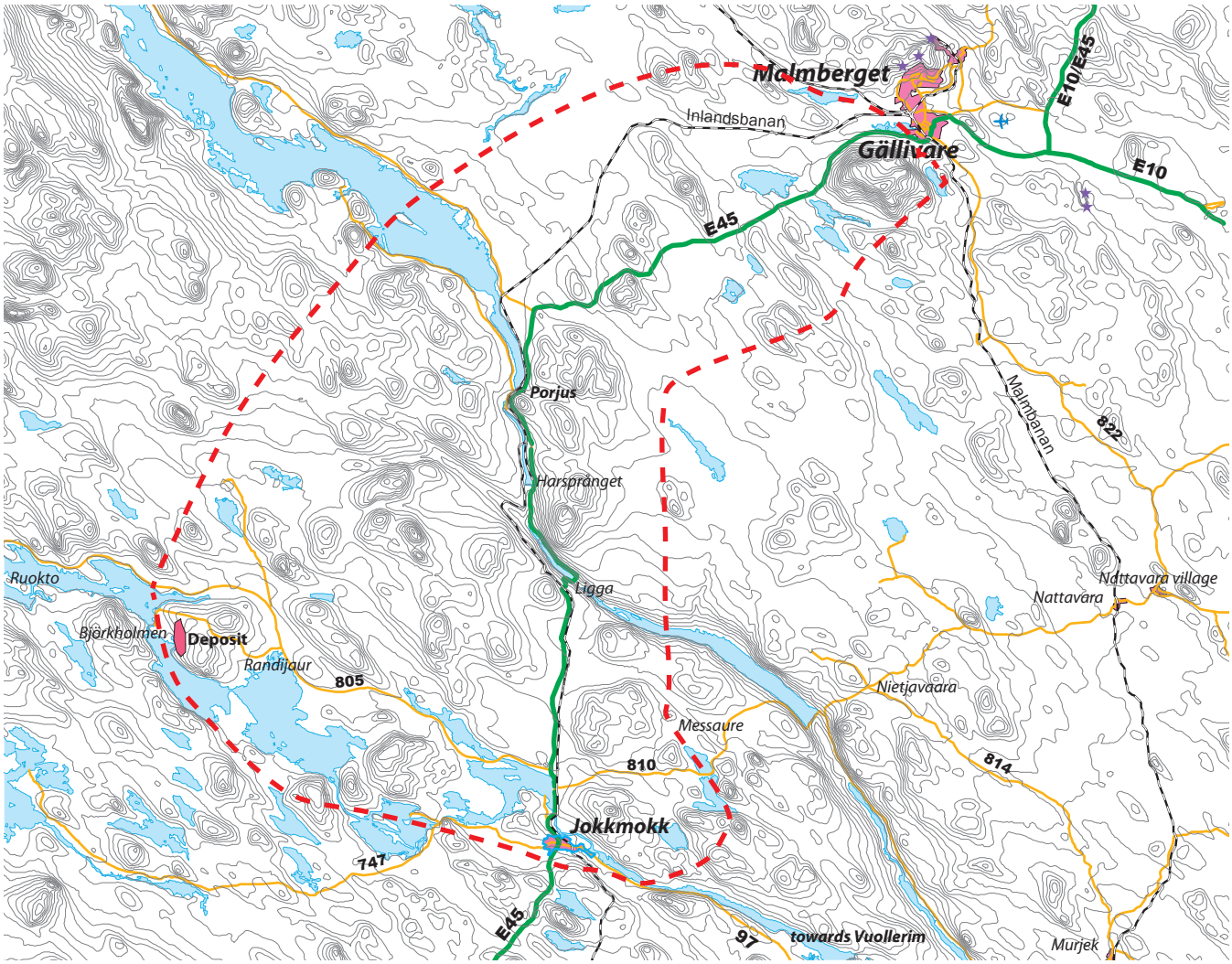


Figure 3.1:1 Geographical scope for this study.

2.2 Scope of content

This study is an initial, broad analysis to highlight the possible potentials of new mining operations in Jokkmokk, necessary infrastructure measures and possible social effects.

To make mining operations possible the transport infrastructure need to allow large volumes from the mines as well as transports of inputs to the mines. Passenger transport is also required to supply the mines with in house labour as well as external contractors.

2.3 Time frame for implementation of measures

The goal is for mining to start around year 2018. This means that the transport infrastructure, particularly for outbound transport of ore concentrate, need to be completed before then.

Since railway transport is the most cost effective, environmentally and climatically appropriate, in-depth investigations need to be initiated promptly. Otherwise there is a risk that high transport and road maintenance costs occur for the time before the railway is completed.

3 Conditions

3.1 The Kallak deposit

The Kallak deposit lies between the villages Björkholmen and Randijaur, about 40 km west-northwest of Jokkmokk.

The Kallak deposit is the largest presently known deposit of so called "quartz mixed iron ore" scheduled to be mined. With an estimated volume of 600 million tonnes, the mine will be able to produce 10 million tonnes of iron ore annually, which results in about 4.2 million tonnes of concentrate per year. The mine in Kallak is comparable in size to the new mines in Pajala. It is estimated to employ about 400 people when operational. The ore is planned to be shipped via Narvik or Luleå port.

Planning stage

The planning of the mine is still at a very early stage. Currently drilling is ongoing and the application for an exploration licence has recently been granted.

The mining company plans to submit an application for an exploitation concession to Bergstaten (the Mining Inspectorate) in the first quarter of 2013.

Then the process for final environmental permit begins.

The plan is for mining in Kallak to start in 2018.

The process from application to mining takes approximately 5 years.

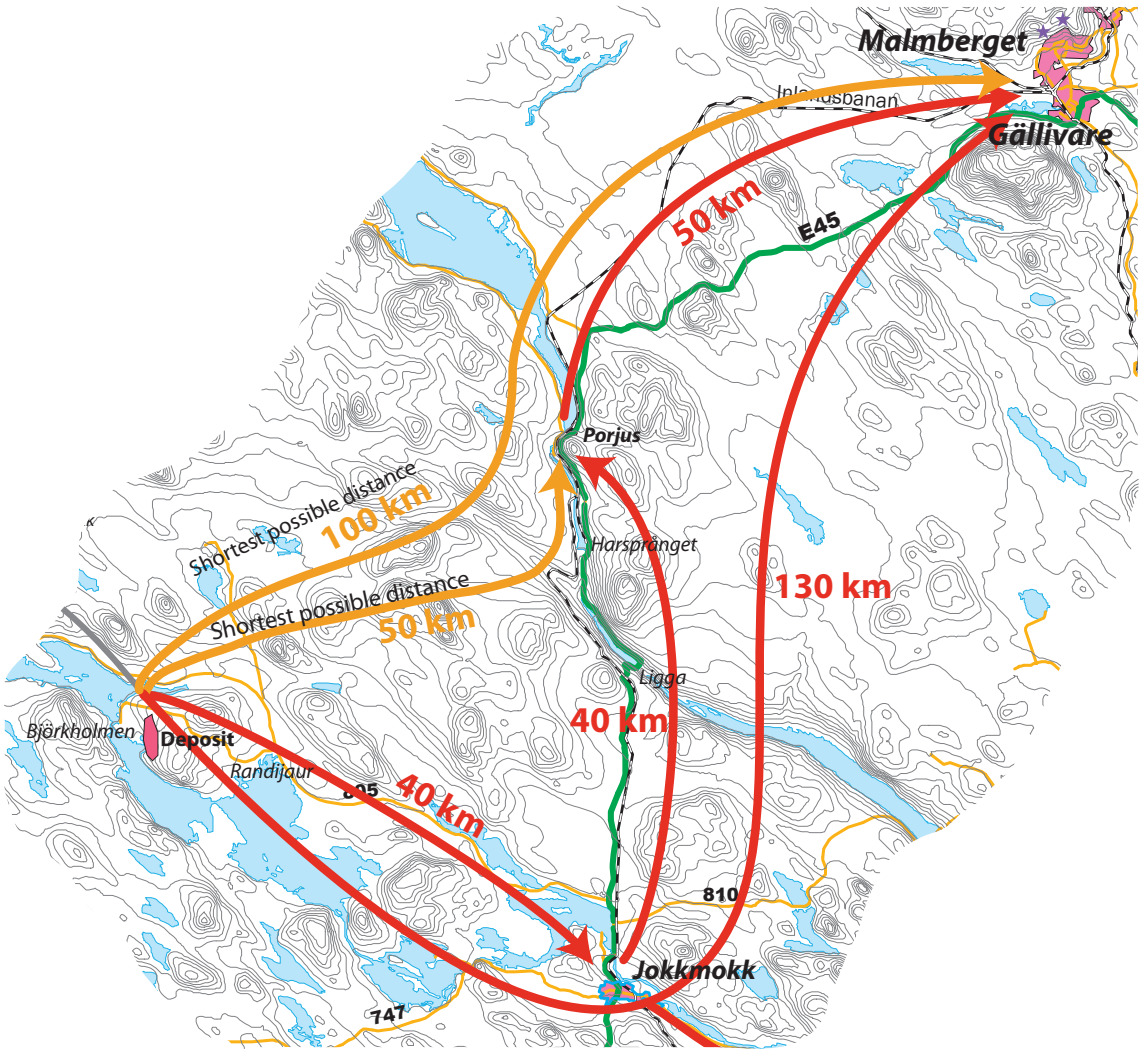


Figure 3.1:1 Current and potential future distances of strategic routes.

Transport volumes during operational phase

The planned mining will generate about 4.2 million tonnes of concentrate annually, which will be the mine's dominant transport volume.

The mine will also need inputs, primarily fuel and raw materials mainly for the manufacture of explosives. Moreover, lining material, reagents etc. will be needed.

Outbound transport	***Tonnes/ year***	***Tonnes/ week***
Concentrate	*4,2 M*	*80 000*
Inbound transport	***Tonnes/ year***	***Tonnes/ week***
Fuel	*6000*	*115*
Raw materials for the manufacturing of explosives	*7000*	*135*
*Milling bodies/lining materials **	*100-1000*	
*Reagents **	*30-800*	
Other	*3000*	*60*

* The volumes depend on the selected enrichment technology. That decision requires the results of a large-scale enrichment experiment to be performed after test extraction.

3.2 Other mining in the region

Northern Sweden is the EU's most important mining region. The ore fields in Kiruna and Gällivare produce around 90 % of the EU's production of iron ore and large growth is planned. Aitik is Sweden's largest copper mine. Mining now also begins in Pajala municipality, which will further strengthen the ore region's significance.

LKAB

LKAB has two mines in operation; Kiruna and Malmberget. During the summer of 2012 a new main level was opened in Malmberget. LKAB is also investing in a new main level in Kiruna. The capacity above ground has also been expanded during the last five years, with a new pellet facility both in Kiruna and Malmberget as well as upgraded logistical infrastructure. LKAB has invested about SEK 30 billion in improvements of logistics and construction of plants during the 2000s. Capacity for greatly increased production has been created. The goal for 2015 is a production of 37 million tonnes of finished iron ore products per year, compared to 28 million tonnes in 2011.

Svappavaara has three mines under reopening: Gruvberget, Mertainen and Leveäniemi. Test extraction has been going on in Mertainen since 2011, and pumping is taking place at the existing open pit in Leveäniemi. For Gruvberget the admissibility process is ongoing.

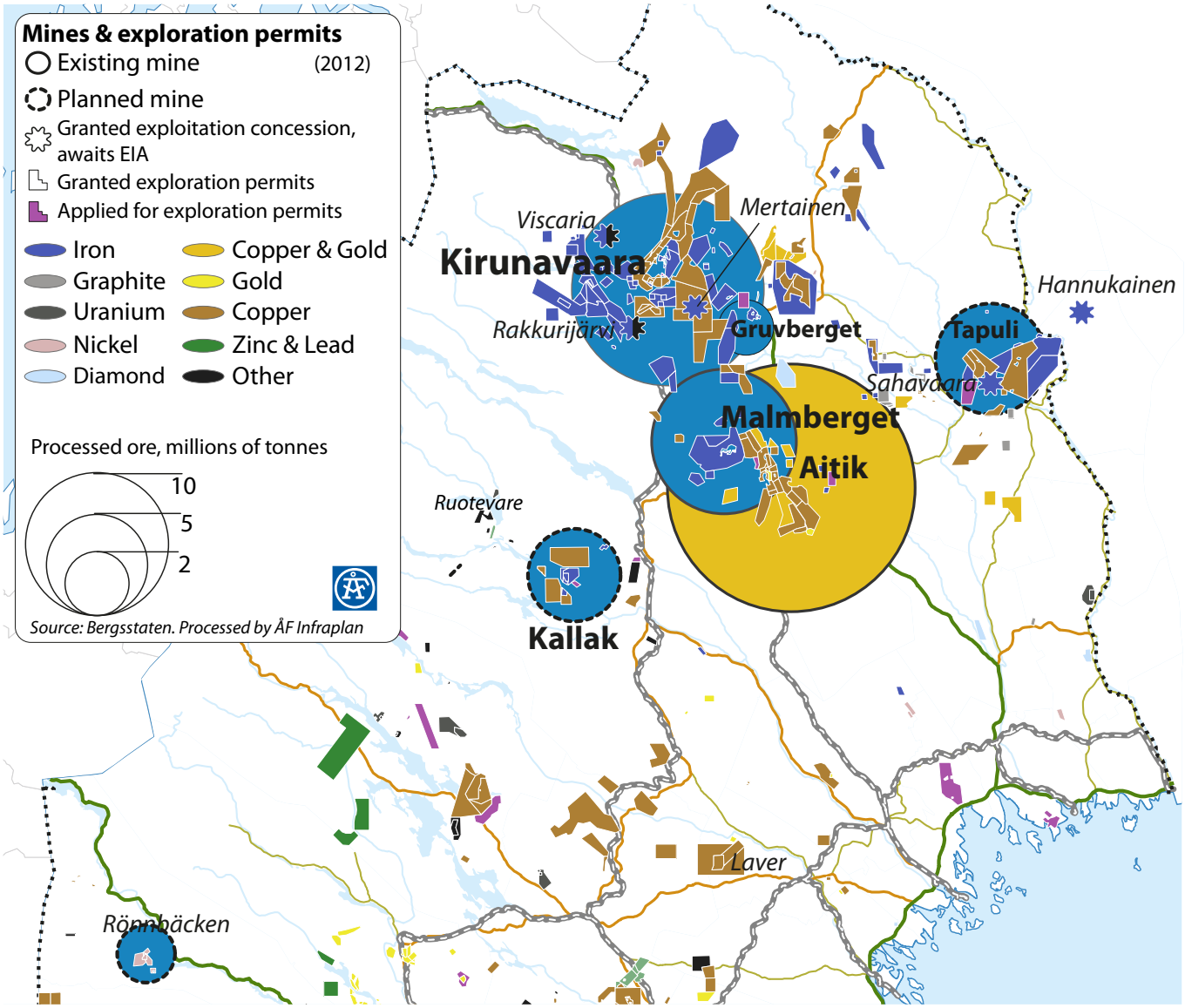


Figure 3.2:1 Mines and exploration permits in northern Sweden.

The Svappavaara mine will be LKAB's second largest mining location with 14-20 million tonnes annual production.

The ore products from Kiruna are transported on the Malmbanan line to the port of Narvik (today about 19 million tonnes/year). The products from Malmberget are transported southwards on the Malmbanan line to Luleå (today about 8 million tonnes/year) both for further processing at SSAB and for transport via the port of Luleå to the Baltic Sea market. The capacity on the Malmbanan line is overstretched. The transport administration plans to initially extend four meeting stations, but further capacity expansion is required (amongst other parts from LKAB, Northland Resources and Norrtåg). The Swedish government has in its infrastructure budget bill given indications that further actions on the Malmbanan line will be prioritized during the revision of the National plan.

Boliden Aitik

The Aitik mine is situated south of Gällivare and is Sweden's largest copper mine. During recent years about SEK 6 billion have been invested in the mine and its processing plant, which will allow for 36 million tonnes of ore extraction during 2014. During 2011 the Aitik mine had a production of 31.5 million tonnes, which was further processed to 267 000 tonnes of copper concentrate for transport by rail to the melting plant in Rönnskär, Skelleftehamn, for further processing.

The Pajala mines

Northland Resources have recently started extraction on the iron ore deposits between Kaunisvaara and Junosuando close to Pajala. They are also planning to start mining in Hannukainen, in the north of Finland.

The identified deposits can together have a volume equivalent to the deposit in Malmberget, ie. more than 300 million tonnes. Initially the production of iron ore concentrate is planned to be about 2 million tonnes, and then increase to 5-6 million tonnes annually by 2014. The concentrate will be transported by 90 tonne lorries from the mine to Pitkejärvi close to Svappavara for reloading to railway for further transport to the port of Narvik.

Prospecting

In Sweden, extensive prospecting is ongoing, which gradually leads to more mines.

The process starts with an application for an exploration permit. If the exploration permits leads to potentially interesting deposits, an application for exploitation concession is made, which can lead to extraction after a period of 4-5 years.

As a result of the high cost for this process and the fact that it is not yielding any profits until start of extraction, the mining companies are reluctant to elucidate conditions for additional deposits. This means that indications of additional deposits are not studied in depth for a longer time frame than 20 years.

In many mining regions, amongst them Jokkmokk, expanded mining of existing and new mines close by can be expected, which needs to be considered when planning the infrastructure.

3.3 Land use

Nature environment

The world heritage Laponia

Laponia was inscribed on the World Heritage List in 1996 and is the only combined natural and cultural heritage in Scandinavia. It is one of only four in the world representing an indigenous landscape. The area covers 9400 square kilometres and consists of the national parks Padjelanta, Sarek, Stora Sjöfallet and Muddus as well as the nature reserves Sjauna and Stubba.

Its nature consists of a series of habitats; mountain massifs, plains, glaciers, bogs, old forests, lakes and rivers of varying size and character. The area has a rich flora and fauna, including many endangered species. Its wilderness character and its high geological and biological values have been the basis for the creation of national parks, nature reserves and it being inscribed on the World Heritage List.

Natura 2000

Natura 2000 is a network of EU:s natural areas worthy of highest protection. Within the studied area there are several, partly coherent areas included in the Natura 2000. These areas and their type of Natura 2000 are summarized in the chart 3.3:2 and figure 3.33. Jelka-Rimakåbbå is situated closest to the Kallak deposit and will be affected by some of the alternative rail routes. Measures that significantly affect the environment in a Natura 2000 site must be authorized by the provincial government and in some cases the government. In Sweden most Natura 2000 are protected under the Environmental Code and are all classified as a national interest. A permit is required for anyone wanting to start opeerations or take actions that might significantly affect the environment in a Natura 2000 area (Chapter 7 § 28a Environmental Code).

The county administrative board considers whether the activity can damage the identified values or have a significant environmental impact. If they determine that no identified values will be damaged a permit can be issued. Otherwise the government will rule on the matter.

Nature reserves

Nature reserves is the most commonly used form of protection. The reserves are protected under the Environmental Code Chapter 7 § 4. Within the geographically defined area of this study, there are several nature reserves in addition to the areas included in the Natura 2000 and listed in the table on the previous page. Serri and Ligga, southeast of the area belong to the larger nature reserves within the study area. In addition, there are some smaller reserves.

According to the Environmental Code, Chapter 7 the County Administrative Board may wholly or partially suspend all decisions issued if there are exceptional reasons. It can include the geographic scope, purpose or regulations. Exceptional circumstances for revocation may be that a reserve no longer have or is able to recover the values that it intended to preserve. The County Board may grant exemptions from the rules of which it has notified if there are special reasons. Special reasons may be deemed to exist if the measure generally has a posi-

Figure: 3.3.1 National parks and nature reserves making up the world heritage Laponia, are situated north and north-west of the Kallak deposit.

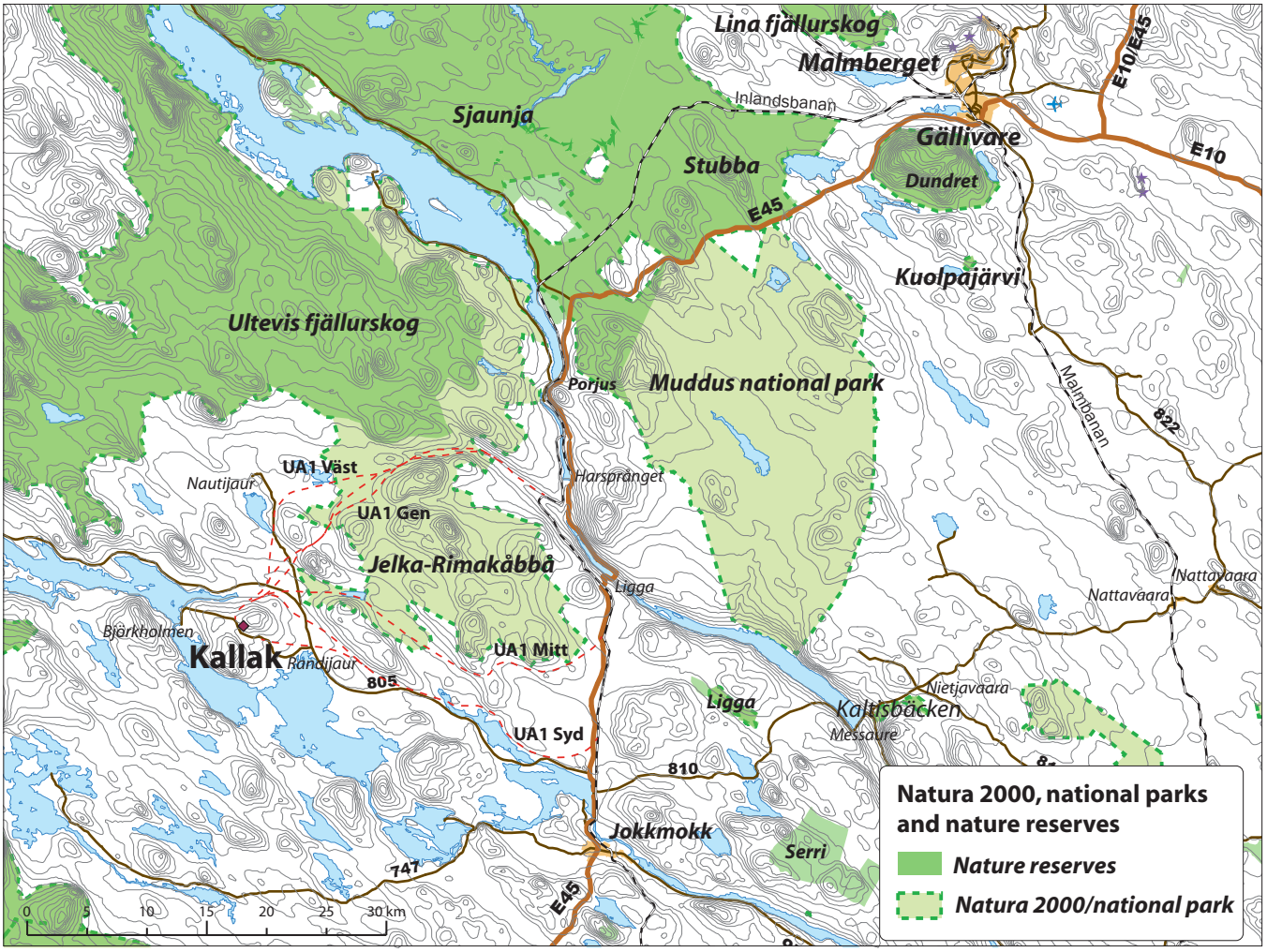


Figure: 3.3.2 Natura 2000-sites within the studied area. Jelka-Rimakåbbå is closest to the Kallak deposit.

namn	Protected by the species- and habitat-directive	Protected by the bird directive	Other form of protection
Muddus	yes	yes	national park
Jelka-Rimakåbbå	yes		missing
Ultevis fjällurskog	yes		nature reserve
Sjaunja	yes	yes	nature reserve
Stubba	yes		nature reserve
Dundret	yes		nature reserve
Lina fjällurskog	yes		nature reserve
Kaltisbäcken	yes		nature reserve
Kuolpajärvi	yes		nature reserve
Ranesvare	yes		nature reserve

Chart: 3.3.1 Synoptic table of Natura 2000 sites around the studied area and their protection type and any additional form of protection

tive impact on the area's prioritized conservation values. Important public interests may be special reasons for exemption.

Changing a reserve can be made by clarifying the reserve's purpose or supplementing regulations.

Decision of repeal or exemption may be granted only if the interference with the nature value is compensated to a reasonable extent within the nature reserve or in another area. Decisions dealing with changing nature reserves must not conflict zoning or area regulations under the Planning and Building Act. Minor deviations may be made, if the purpose of the plan or the regulations is not counteracted.

Key biotopes, nature value sites, freshwater swamp forest and nature conservation agreements

Key biotopes are forests with very high nature values.

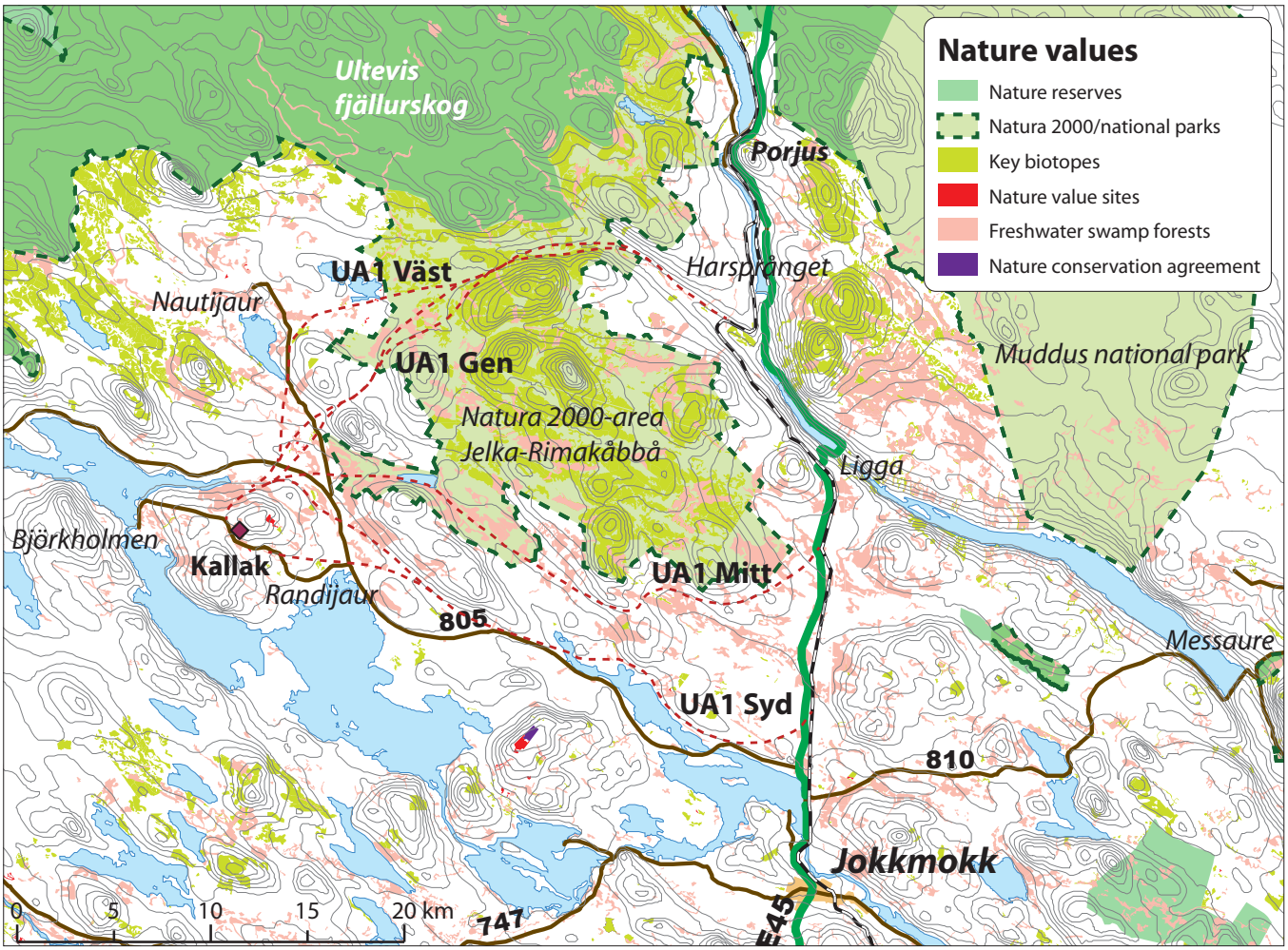


Figure 3.3:3 Nature values in potentially affected areas

These forests have characteristics that give them a key role for threatened animals and plants. It is critical for the forest industry to know where these areas are located in order to live up to its responsibility to preserve biodiversity. The Board of Forestry takes inventory on small-scale forestry areas, while the large-scale forestry inventory their holdings of key biotopes. Registered key biotopes within the study area are mainly around Ågås and Stuor-Dábmuk west of Harsprånget, located within the Natura 2000-area Jelka-Rimakåbbå.

Nature value sites

Nature value sites are elements that have been identified as important for biodiversity and in the future may be part of a key biotope, if left untouched, or cared for. In the study area natural value items are identified on Björkholmen, on the peninsula southeastward, north, east and south of Nautijaur and just north of the lake Klubbuddsjön.

Freshwater swamp forests

A large part of Sweden is covered by moist or wet forests, known as freshwater swamp forests. These are characterized by low growth rates over time, which result in high biodiversity. Swamp forests are overgrown wetlands that are important for an area's hydrology. During identification of swamp forests they are classified as wetlands of class 1, 2, 3 or 4. The most worthy of protection, class 1, should be left untouched and looked after so that the values can be preserved. Class 2 should as far as possible be left intact. Wetlands class 3 have certain values and should be left intact, but some encroachment may be permitted if the impact on the natural and cultural values can be limited. Wetlands Class 4 have low conservation value and forestry can be conducted or other exploitation occur.

In the study area there are both small, separated areas and large coherent areas of swamp forest. Wetlands of all nature classes exist in the area.

The reindeer industry

The area surrounding the proposed mining area is used by the Sami villages Jåhkågaska tjiellde (mountain Sami), Tuorpon (mountain Sami), Sirges (mountain Sami) and Serri (forest Sami). Migration routes pass the planned mining area between the area above and below the cultivation border. Collection areas, resting pastures, pastures and working pastures are situated nearby and several in the area are classified as being of national interest.

Figure 3.3:4 below shows the strategic locations of Sami villages and functional connections. Figure 3.3:5 on next page shows the areas of national interest.

The map below shows a selection of key locations and conditions during an average year. Actual conditions may vary. Variations occur from year to year, and are linked to a number of factors such as weather conditions and the interaction between the Sami villages.

The map shows each Sami village´s total grazing area. These grazing areas may overlap, for example, in the area south of Harsprånget, where both Serri and Sirges pastures are located. Even the surrounding, not mentioned Sami villages, can periodically use the area studied.

Alternatives	Sami villages whose pastures are affected
UA1 Väst	Jåhkågaska tjiellde, Sirges, Serri
UA1 Gen	Jåhkågaska tjiellde, Sirges, Serri
UA1 Mitt	Jåhkågaska tjiellde, Sirges, Serri
UA1 Syd	Jåhkågaska tjiellde, Sirges, Serri, Tuorpon

Chart 3.3:2. The investigated options passes through pastures used by four Sami villages.

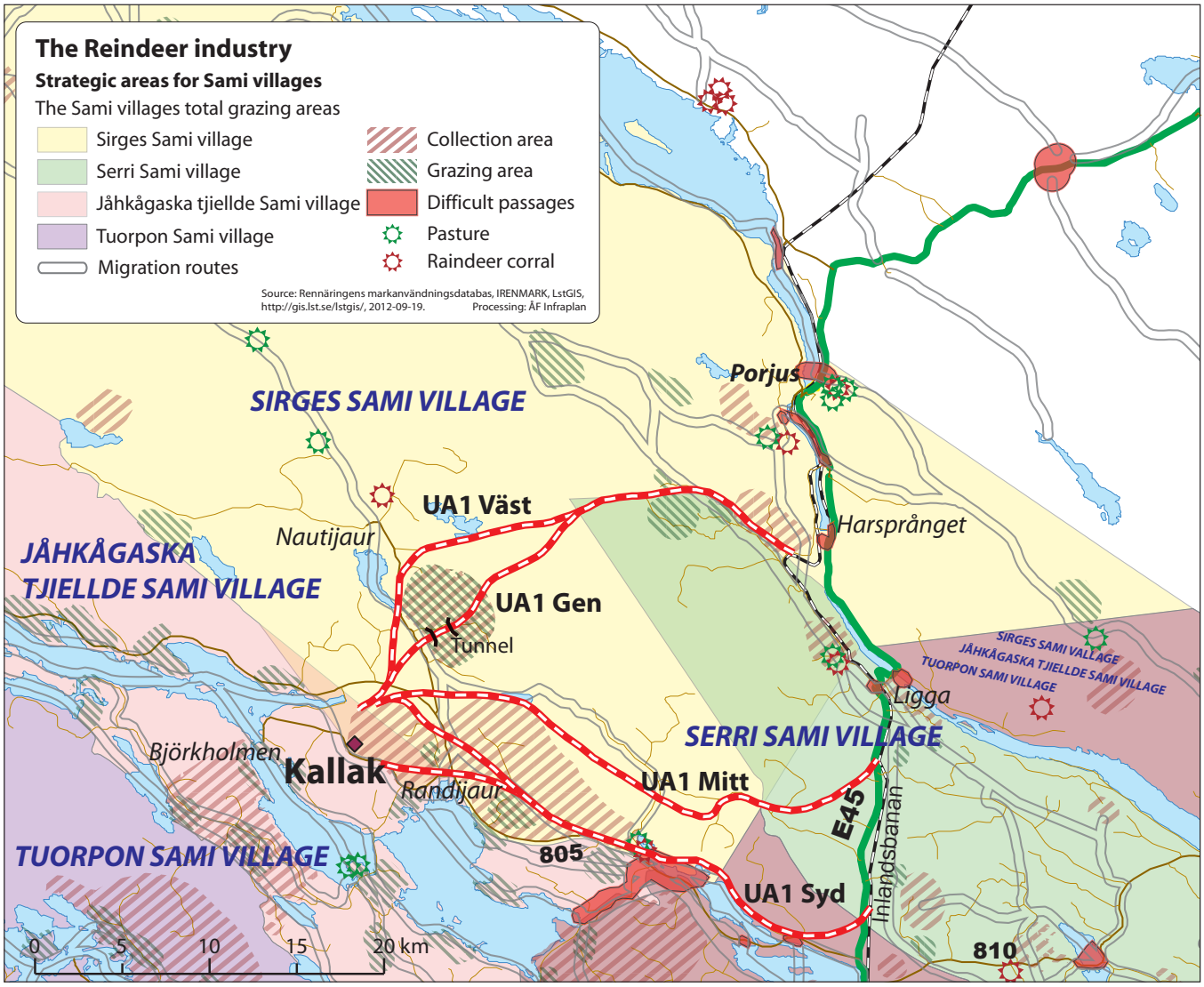


Figure 3.3:4 The reindeer industry's interests in and around the area affected by the planned mine.

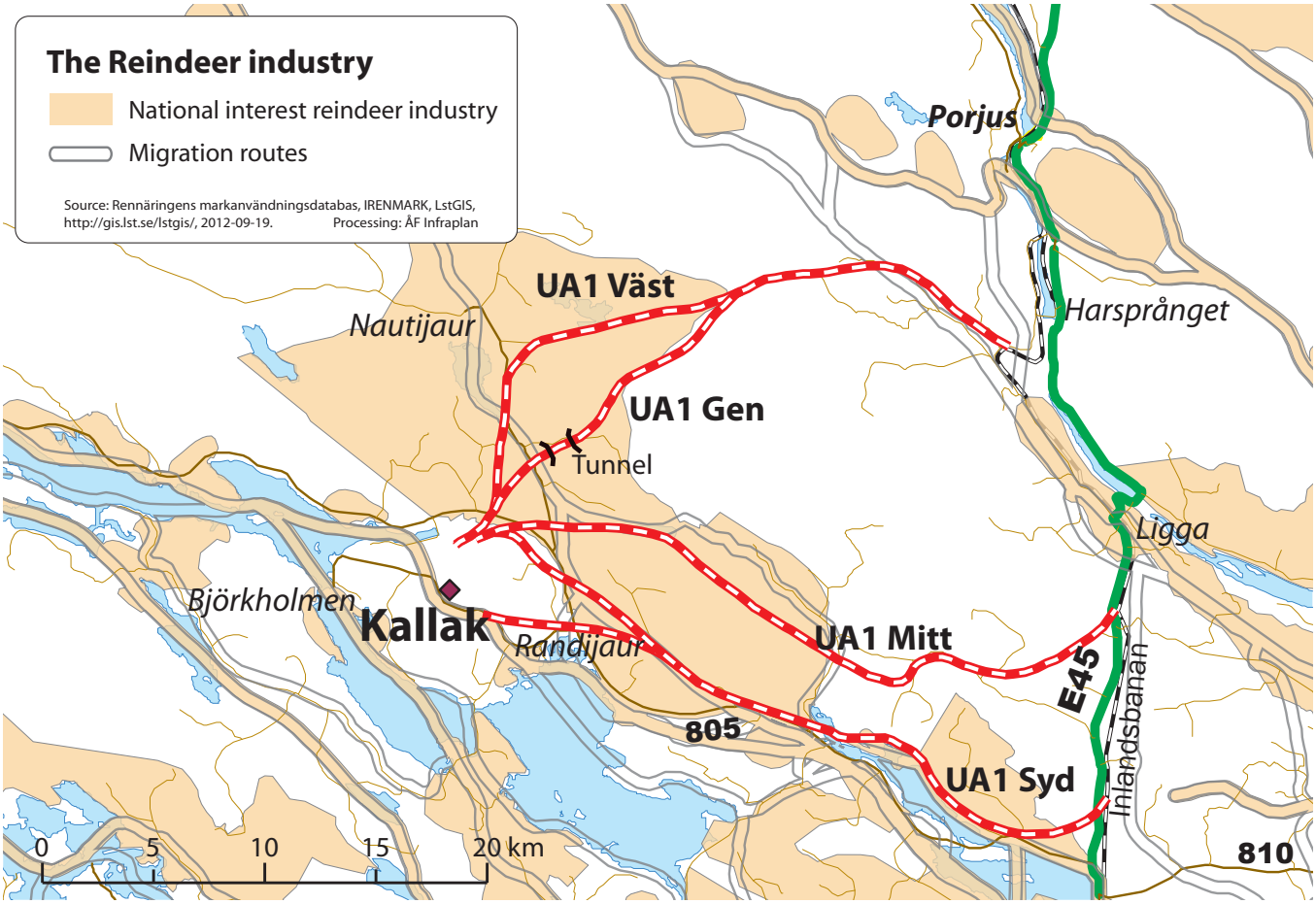


Figure 3.3:5 Areas of national interest for reindeer herding. Locations and areas in Figure 3.2.1 has guided the establishment of national interest areas.

Recreation, hunting and fishing

Road 805 is important for tourism to/from Kvikkjokk and Sarek and Padjelanta area.

No national interest for recreation is affected by the proposed mining operation and its infrastructure needs.

Hunting is carried out and fishing takes place in lakes and streams in the area.

Figure 3.3:6 The road to the planned Kallak mine is used to reach Sarek and Padjelanta national parks.

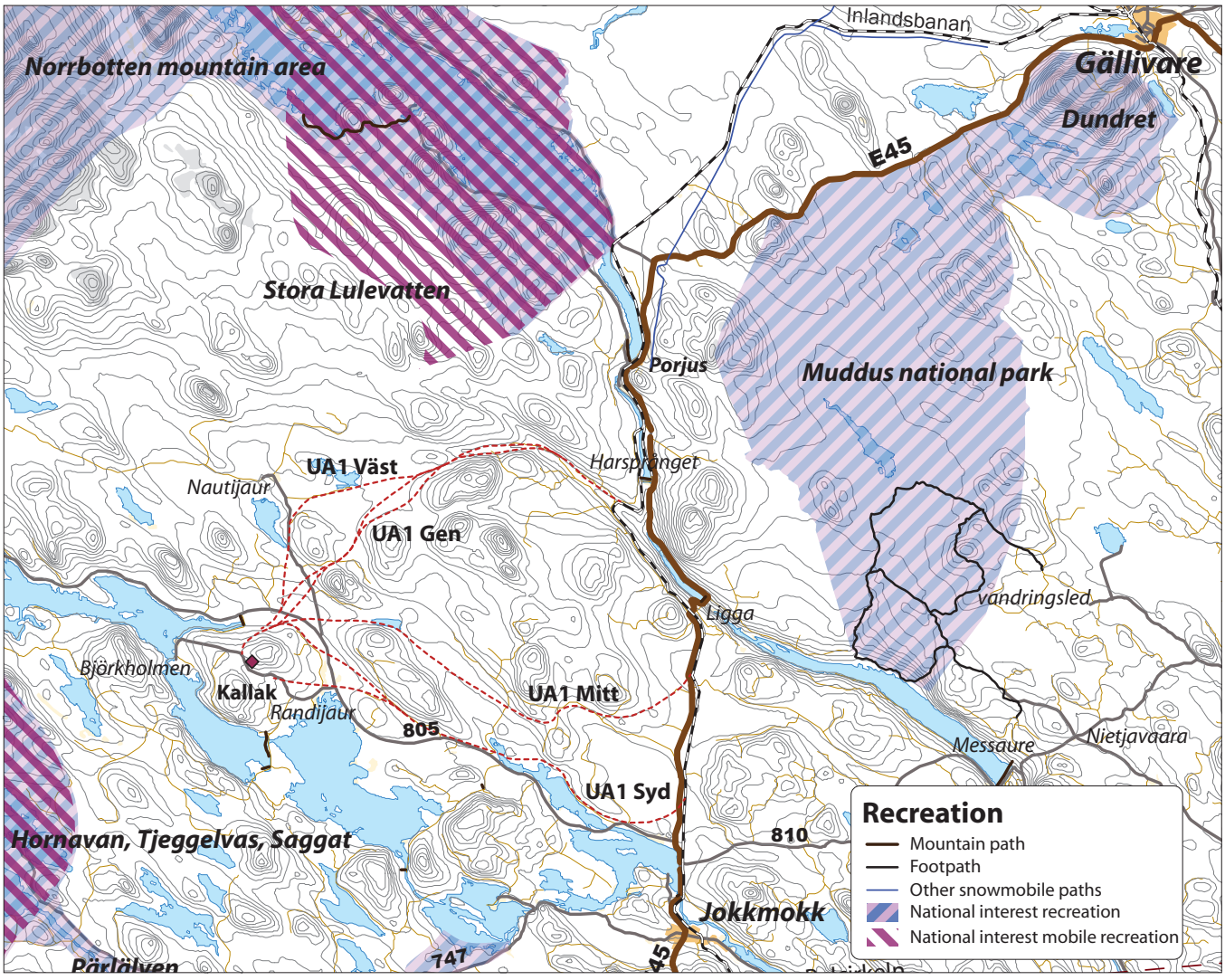


Figure 3.3:7 National interest for recreation.

3.4 Population pattern and social functions

The population in Jokkmokk grew during the era of hydropower development. Nowadays most of Vattenfall´s employees for this nationally prominent hydropower municipality are primarily located in Stockholm.

Jokkmokk municipality has 5065 inhabitants (30 september 2012). Available services are mainly in central Jokkmokk. Even Vuollerim and Porjus have both grocery stores, schools and other public services.

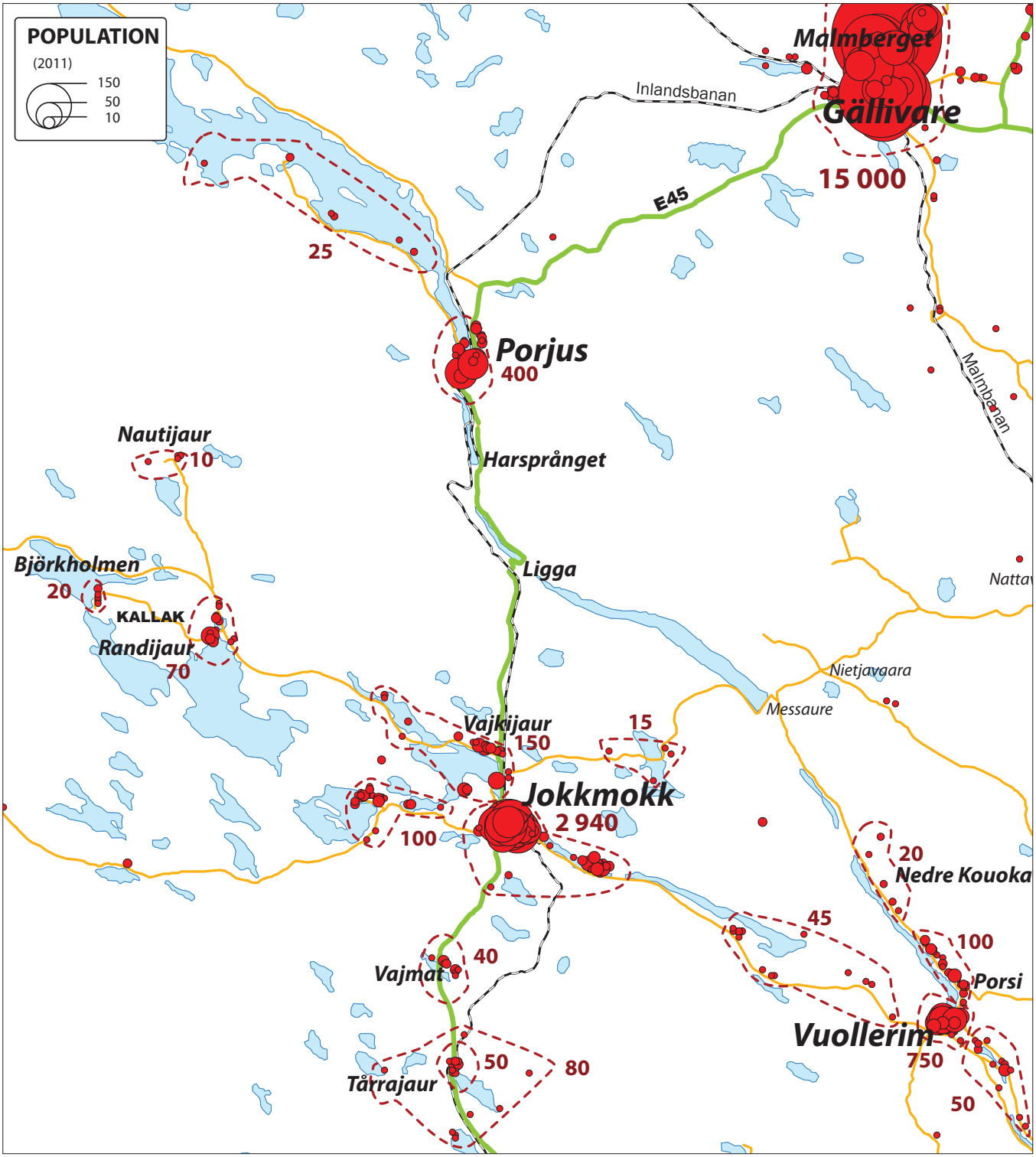


Figure 3.4:1 Local structure in the area around the planned mine.

Close to the mine there are a few small villages with altogether about 100 inhabitants. Jokkmokk has three urban localities:

• Jokkmokk with about 3 000 residents about 40 km east-southeast of Kallak

• Vuollerim with close to 1 000 inhabitants (including surrounding villages) over 80 km from Kallak

• Porjus with about 400 inhabitants about 80 km road distance from Kallak but only about 35 km away as the crow flies.

Jokkmokk has, like most inland municipalities, a women's deficit in economically active ages and a deficit of young families.

Overall, the region surrounding Kallak is very sparsely inhabited, which requires long-term strategies for the necessary expansion of housing and services, which can contribute to a long-term sustainable, efficient mining operation and well functioning related and complementary industries.

At a road distance of 90 km from Jokkmokk Gällivare is situated. Gällivare has significant access to entrepreneurs within and related to the mining industry and also with a hospital.

Arvidsjaur is 155 km south of Jokkmokk and Älvsbyn about 140 km south-southeast of Jokkmokk.

Boden is situated 134 km southeast of Jokkmokk and the county center Luleå at a road distance of 164 km.

Jokkmokk municipality has limited commuting across the municipal border, mainly due to the long distances.

The majority of the commuting is from Porjus to Gällivare (about 50 km), while 90 km from Jokkmokk to Gällivare is perceived too far for daily commuting.

Weekly commuting occurs to/from Gällivare, Kiruna and Luleå.

3.5 The transport system

Road and railway

E45

E45 between Jokkmokk and Gällivare:

Relatively good standard Jokkmokk-Ligga and Porjus-Gällivare.

The road Ligga-Porjus is slightly more narrow compared to other parts.

Road gradients are in some places steep, which may influence the choice of lorries. Heavy vehicles with special exemption may have problems keeping speed in steep inclines if they are not equiped engines powerful enough.

Road 805

Road 805 between Vaikijaur (at E45) and Kvikkjokk:

- The road is classified as an essential to businesses but has a low standard, particularly regarding load bearing capacity. Road width is about 6.5 meters.
- Feasibility studies for gradual upgrading has been carried out by the Swedish Transport Administration (Trafikverket). Stage 1 is completed but does not affect mining transports. Trafikverket has postponed stage 2 and 3 due to mining having special requirements for the road.

The distance between Kallak and the connection to E45 is 38 km.

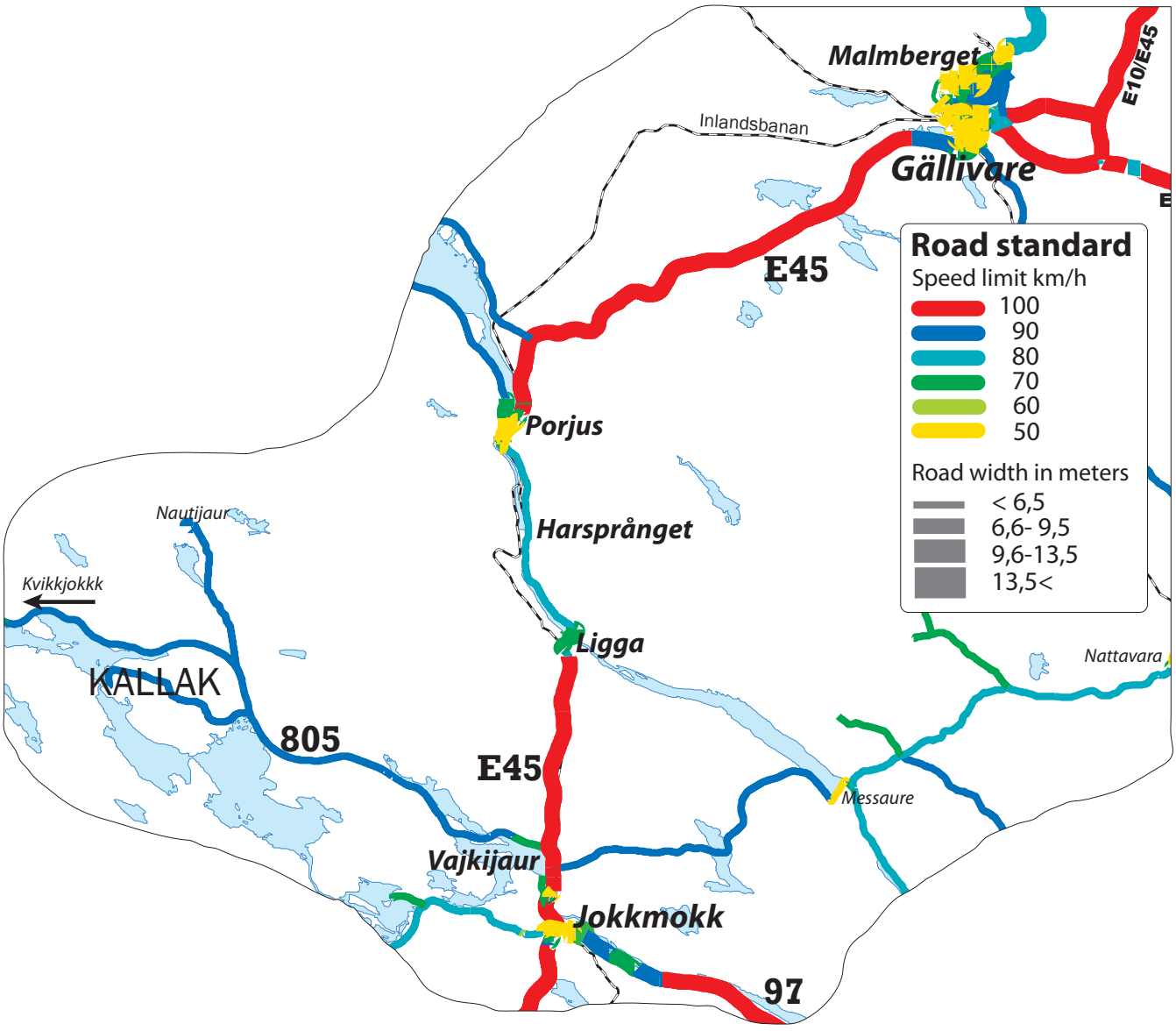


Figure 3.5:1 Road standards for affected roads regarding speed limits and road width.

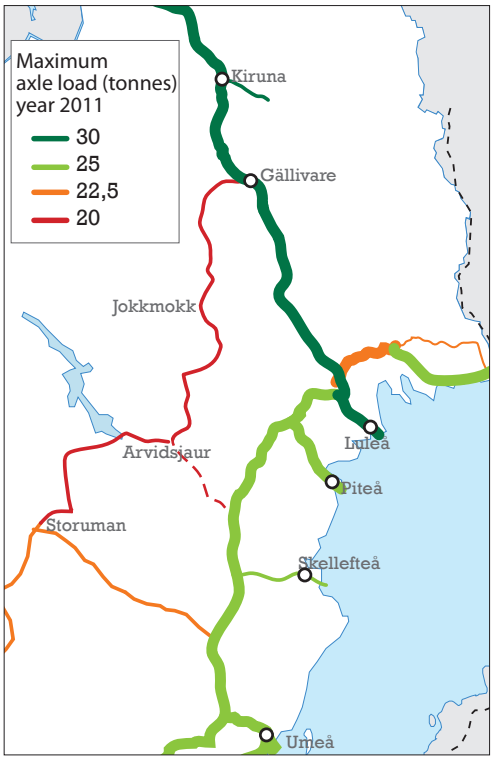


Figure 3.5:2 Malmbanan with STAX 30 tonnes and Inlandsbanan with STAX 20 tonnes.

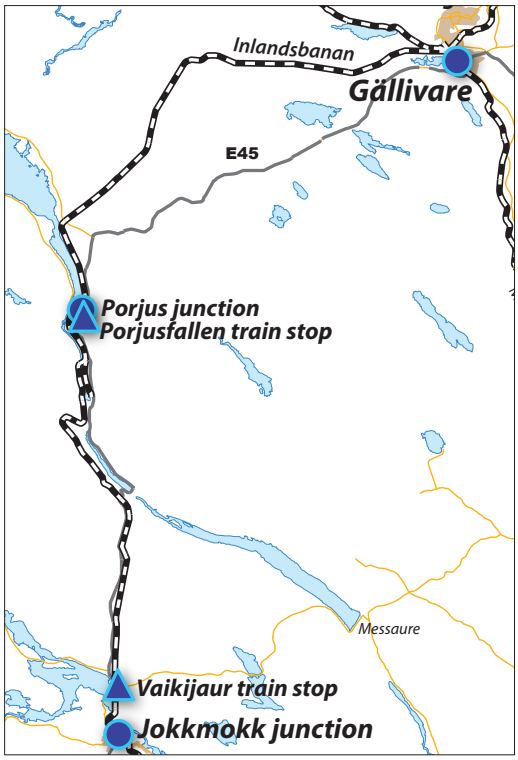


Figure 3.5:3 Junctions and stops along Inlandsbanan.

The Malmbanan line

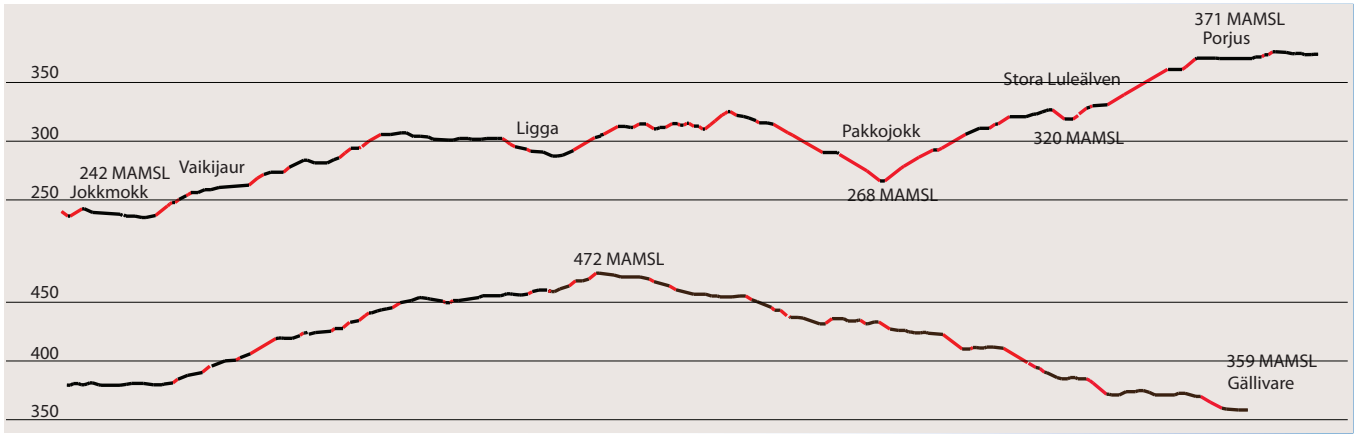
The Malmbanan line is Sweden's most heavily trafficked railway and is used primarily by ore trains. It is the only railway in Sweden, allowing 30 tonnes axle load and 8600-tonne heavy trains. The Northern circuit (Kiruna-Narvik) carries about 19 million net tonnes of ore per year. The Southern circuit (Luleå-Boden-Gällivare-Kiruna) carries about 8 million net tonnes.

The route is also operated by remote freight trains, night trains and regional passenger trains.

The Inlandsbanan line

The Inlandsbanan line allows 20 tonnes axle load on the part Jokkmokk-Gällivare. The railway line is hilly, and many parts are have gradients steeper than 10 per mil, which is the maximum when building new railway.

Currently the famous Jokkmokk - Gällivare line is only serving passenger with tourism adapted timetables with daily departures during summer season. Three trains with lime are now being tested between Orsa (Kallholsfors) and Gällivare. The trains are approximately 1000 tonnes heavy and may become 75 transports plus 75 return transports per year on the Inlandsbanan line.



Figur 3.5:4 Elevation Profile of Inlandsbanan Jokkmokk-Gällivare. The red sections have gradients higher than 10 per mil.

Northern Sweden has a large number of unit trains, see figure 3.5:6.

Kallaks ore transports on railway will use the same routes/lines that are currently serving some of LKAB's ore trains.

The Norwegian ARE trains for fish transport operates throughout the Malmbanan line.

Near Luleå there are additional unit train structures.

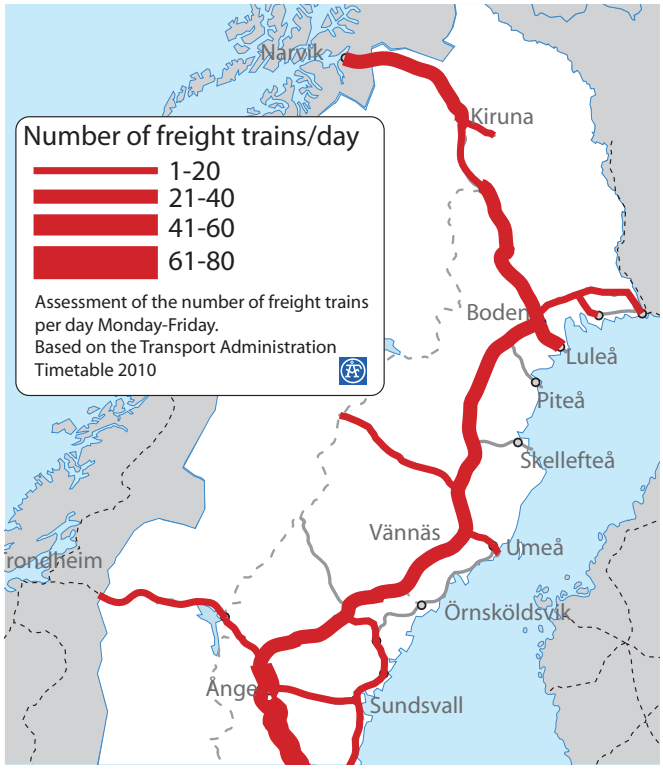


Figure 3.5:5 Freight trains in the region.

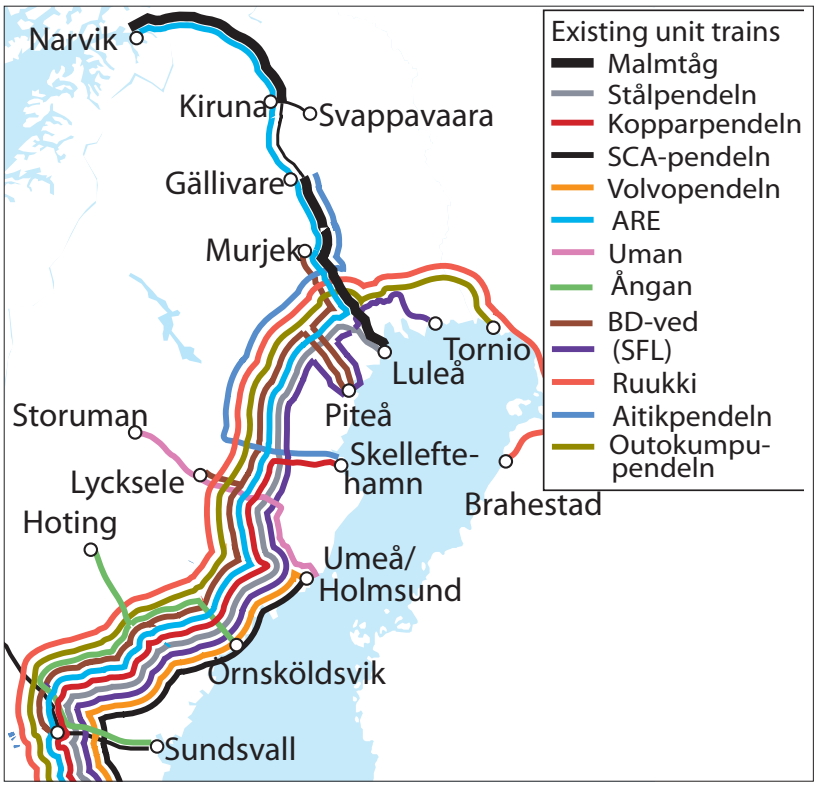


Figure 3.5:6 Unit trains in the region.

Logistics in figures (LKAB:s ore transports)
Each train carriage carries: 100 tonnes.
Each train set carries in total: 6800 tonnes.(68 carriages/train, so called long trains).
The long trains are 750 meters.

Traffic and capacity situation

Traffic requirements along the 500 km of the Malmbanan line have gradually increased. Mining operations require more, longer and heavier trains.

Since the Malmbanan line is a single-track railway, yards have a central role in making the traffic run with good capacity. From Kiruna to Narvik there are currently 11 ore trains/day and from Malmberget to Luleå 5 ore trains/day.

Even the Svappavaara ore and Pajala ore will be transported on the northern curcuit starting in Svappavaara.

The Pajala ore is transported by lorry from Kaunisvaara to Svappavaara to be reloaded at their own terminal. Green Cargo will have four circuit timeslots/day for Northlands ore on the Malmbanan line to Narvik.

Boliden uses the line for ore transports from Aitik / Gällivare to Rönnskärsverken / Skelleftehamn.

In addition to ore traffic the line is used for timber transport and the Norwegian ARE trains for fish transports. Besides this there are two night trains per day and 10 passenger trains per day.

The Inlandsbanan line is operated daily with passenger trains and tourism adapted timetables during the summer season. Every day a train starts from up north (Gällivare) and one from the south (Östersund). For 2013, the time period for these tourism trains is preliminarily 3/6 to 25/8.

The Inlandsbanan line´s northern part has no capacity problems with current traffic. Increase is possible, but extensive ore transports may require some additional passing station.

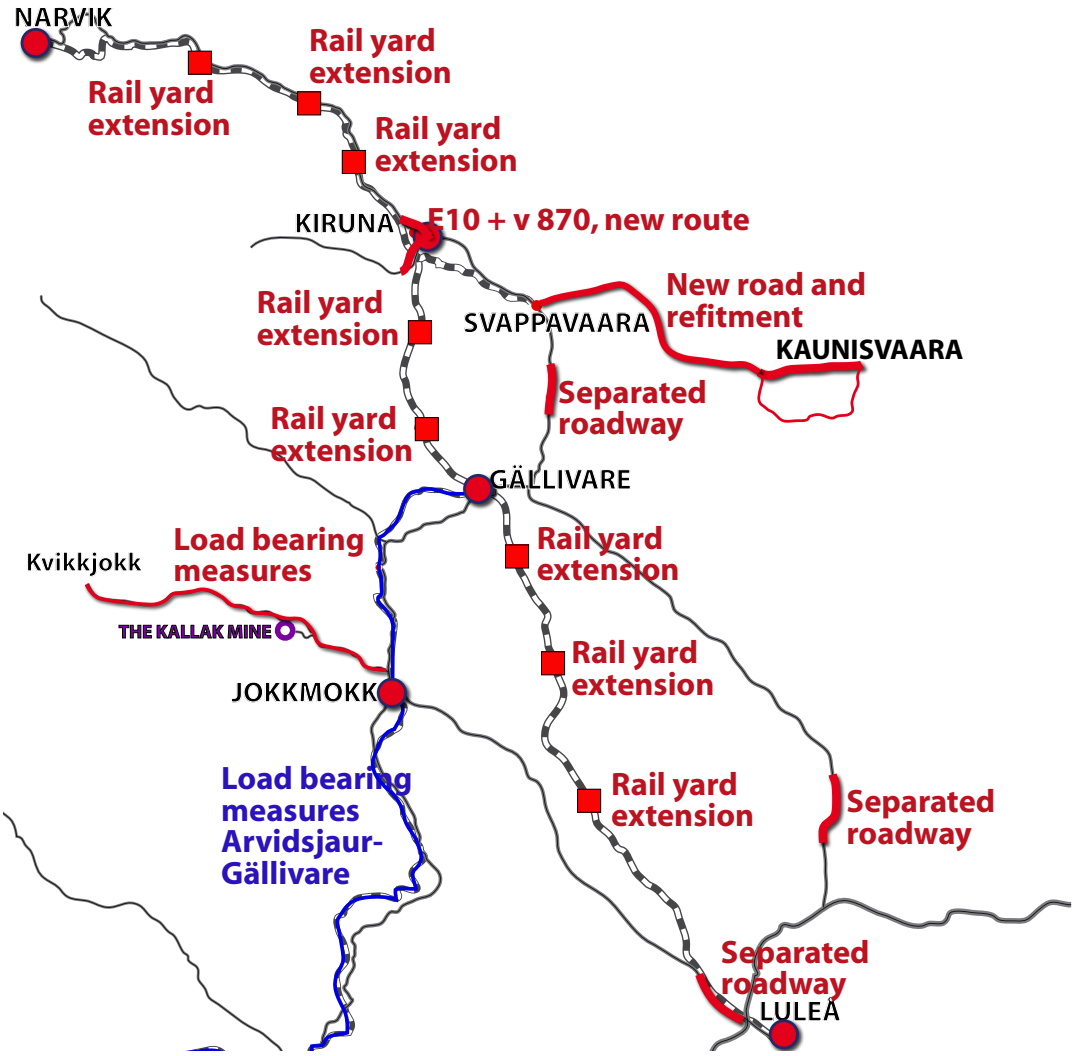


Figure 3.5:7 Planned investment measures (red) and Inlandsbanan's identified upgrading needs Arvidsjarur-Gällivare to STAX 22.5 for about 550 MSEK (blue).

Planned investments and measures

The Malmbanan line

The significant increase in ore production in northern Sweden means increased traffic on the Malmbanan line and severe capacity problems if the necessary measures are not implemented.

LKAB has invested heavily in new wagons and locomotives and in other measures to increase capacity to serve more full-lenght train (750 meters).

Four passing stations are extended to increase capacity on the line.

The Government has indicated that further investment of about SEK 3.5 billion, will be considered for mining-related infrastructure over the period 2013-2017. The capacity of the Malmbanan line is increased (around SEK 800 million) and the road between Kaunisvaara and Svappavaara is upgraded (around SEK 1.3 billion). Of the SEK 3.5 billion some is also going to the district Bergslagen.

The Inlandsbanan line

The Inlandsbanan line investigates the standard of existing line.

E45

The Swedish Transport Administration (Trafikverket) has currently no projects involving E45 between Jokkmokk and Gällivare.

3.6 Aim of measures/ problem solving

The aim of the measures is:

- A sustainable transport solution before the start of mining
- An economically benificial solution
- An environmental and climaticly reasonable solution
- A socially sustainable solution

4 Studied alternatives

4.1 Possible types of measures

1. New railway Kallak- the Inlandsbanan line 30 tonne permissible axle load and electrified. Upgrade and electrification of the Inlandsbanan line to Gällivare.

2. Lorry (90 tonne) to the Inlandsbanan line, upgrade of the Inlandsbanan line Gällivare to 30 tonne axle load and electrification

3. Lorry (90 tonne) Kallak -Gällivare

4.2 UA 1: New railway and upgraded Inlandsbana line (inland railway)

A great number of solutions have been tested at an idea stage. The topography of the area makes short transport solutions difficult.

The following route options have been studied:

- UA1 GEN (”SHORT”), around 99 km Kallak-Gällivare
- UA1 VÄST (”WEST”), around 102 km Kallak-Gällivare
- UA1 MITT (”MID”), around 117 km Kallak-Gällivare
- UA1 SYD (”SOUTH”), around 122 km Kallak-Gällivare

UA1 GEN ("SHORT")
New route 34 km Kallak- south Harsprånget and upgrading of the Inlandsbanan line 65 km. The new route consists of railway at ground level, cuts and banks and a tunnel. In total, around 200 m bridge and 1800 m tunnel are required. The connection to the Inlandsbanan line is just south of Harsprånget.

The alternative also includes a new triangular junction between the Inlandsbanan line and the Malmbanan line near Gällivare. The triangular junction facilitates transports to/from Narvik and requires less space capacity in Gällivare.

UA1 VÄST ("WEST")
New route 37 km Kallak- south Harsprånget and renovation of the Inlandsbanan line 65 km. The new route consists of railway at ground level, cuts and banks. A total of around 550 m bridge is required. The connection to the Inlandsbanan line is just south of Harsprånget as for option UA1 GEN (”SHORT”).

The alternative includes a new triangular junction between the Inlandsbanan line and the Malmbanan line near Gällivare. The triangular junction facilitates transport to/from Narvik and requires less space capacity in Gällivare.

UA1 MITT (”MID”)
New route 37 km Kallak- south Ligga and renovation of the Inlandsbanan line around 80 km. The new route consists of railway at ground level, cuts and banks. A total of around 200 m bridge is included in the tested line.

The alternative also includes a new triangular junction between the Inlandsbanan line and the Malmbanan line near Gällivare. The triangular junction facilitates transport to/from Narvik and requires less space capacity in Gällivare.

UA1 SYD ("SOUTH")
New route 34 km Kallak - north Jokkmokk (around 42 km if connection to the mine is selected north of the processing plant). Upgrading of the Inlandsbanan line around 88 km.

The new stretch consists of railway at ground level, cuts and bank. A total of around 750 m bridge is required in the tested line.

The connection to the Inlandsbanan line is just north of road 805 north of Jokkmokk.

The alternative also includes a new triangular junction between the Inlandsbanan line and the Malmbanan line near Gällivare. The triangular junction facilitates transport to/from Narvik and requires less capacity space in Gällivare.

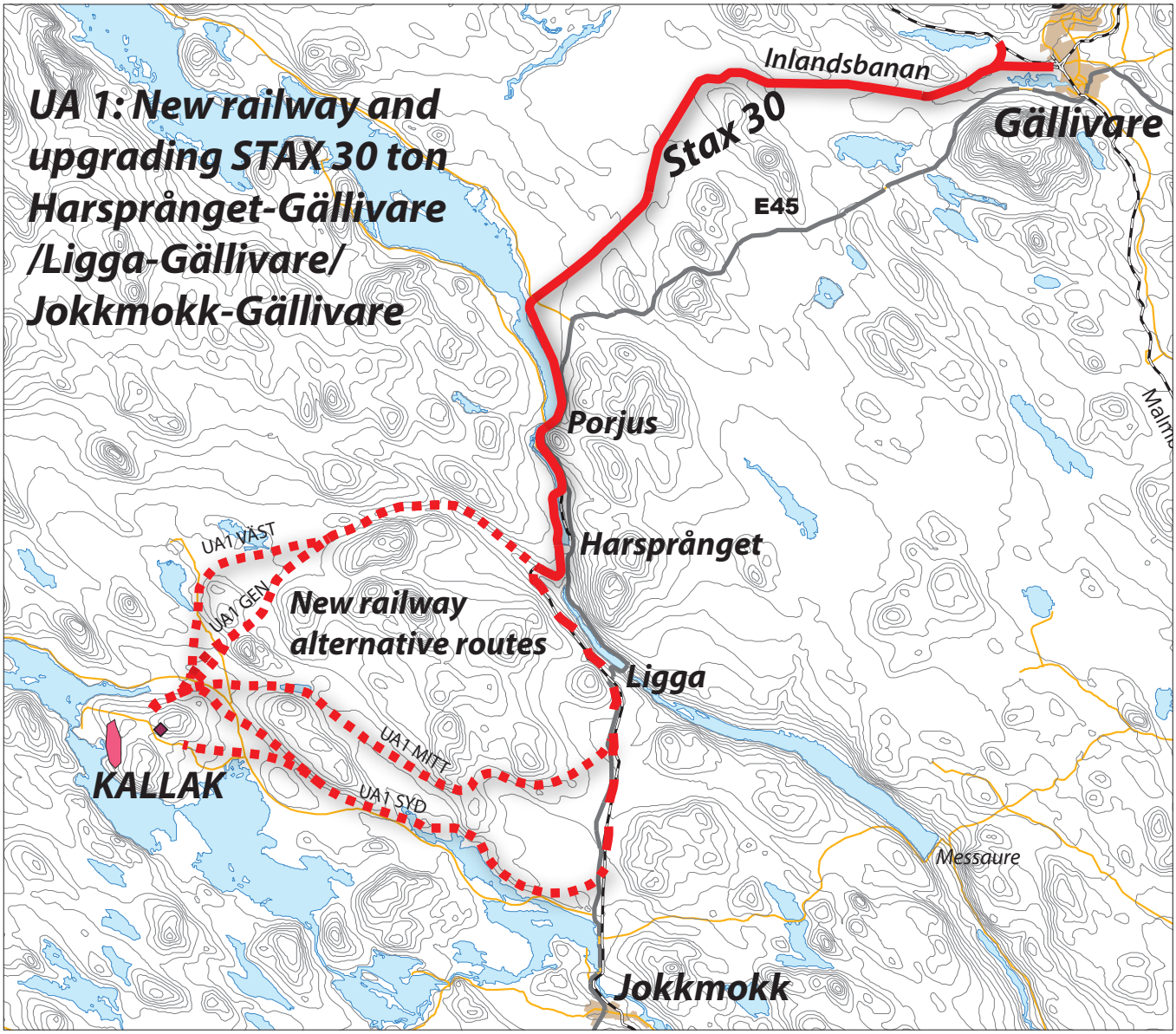


Figure 4.2:1 Alternative railway measures.

4.3 UA 2: Lorry Kallak - the Inlandsbanan line

Upgrading of road 805 is required between Kallak and the connection to E45 and a short upgrade of E45 to the terminal that is discussed for this alternative.

The Inlandsbanan line is upgraded around 93 km between the terminal just north of Jokkmokk and Gällivare. A triangular junction is built between the Inlandsbanan line and the Malmbanan line west of Gällivare.

For the lorry transport it is assumed that exemption for 90 tonnes total weight will be granted, which however requires upgrading of the load bearing capacity of road 805.

Northland Resources who have establishes iron ore mines in Pajala have received exemption for 90 tonne lorries and will use the Scania R730. These rigs can load a maximum of around 62 tonnes. We assume that vehicles with similar load characteristics will be used for ore transports from Kallak.

Figure 4.3:2 90-tonne lorry for ore transport. Northland Resoruces have ordered 400 lorries at a total cost of SEK 1.5 billion. Photo: Northland Resources

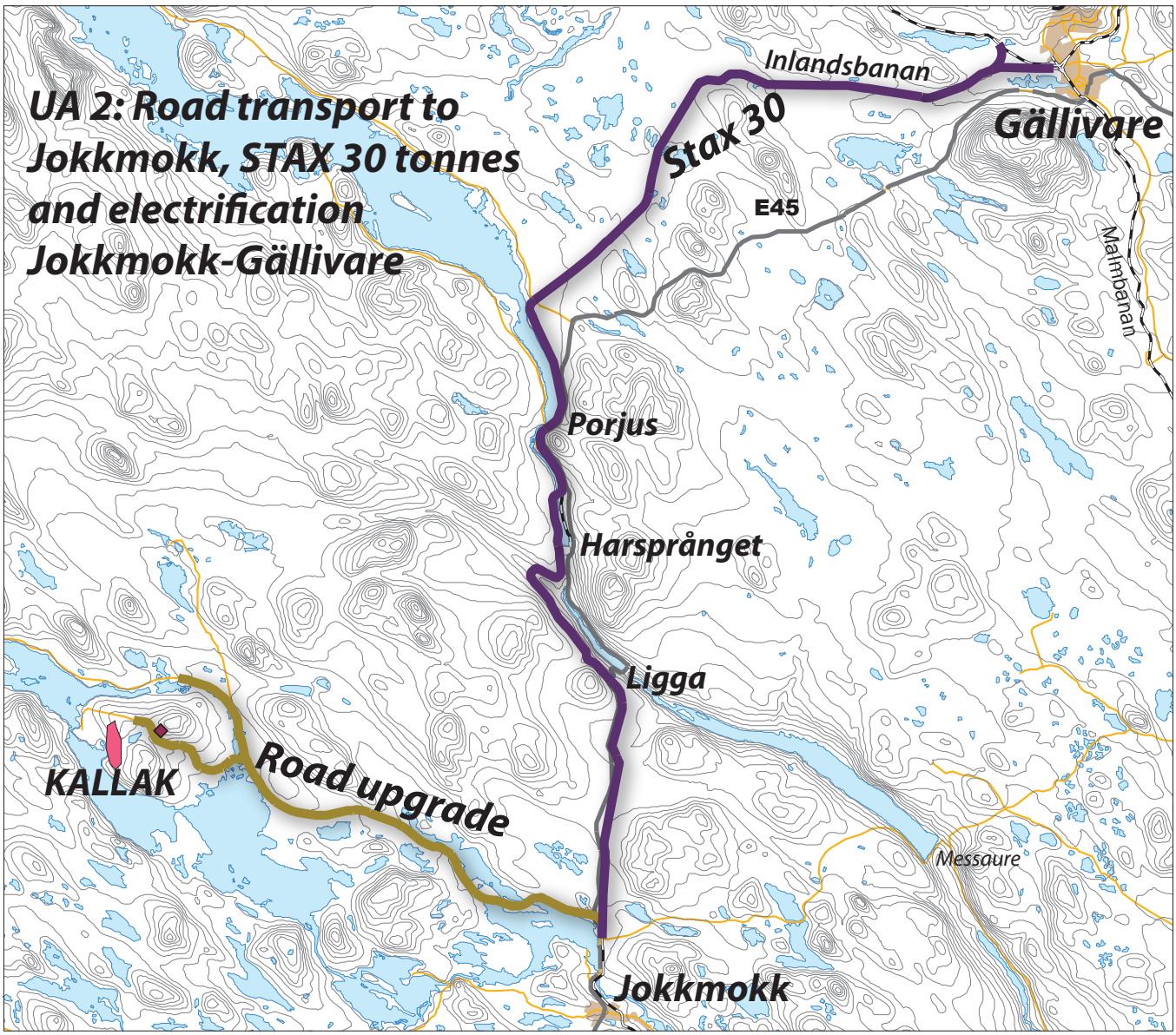


Figure 4.3:1 Combined road and rail solution.

4.4 UA 3: Lorry to Gällivare

Upgrading of road 805 between Kallak and the connection to the E45. E45 needs upgrading on the 87 km long route from road 805 to Gällivare.

Connection to the railway is assumed at a terminal east of Gällivare at Nattavaaravägen.

For lorry transport it is assumed, as in UA2, that exemption for 90 tonnes total weight is granted.

The same type of lorries is assumed as for lorry transport in UA2. At 90 tonnes total weight, the maximum load is assumed to be around 62 tonnes.

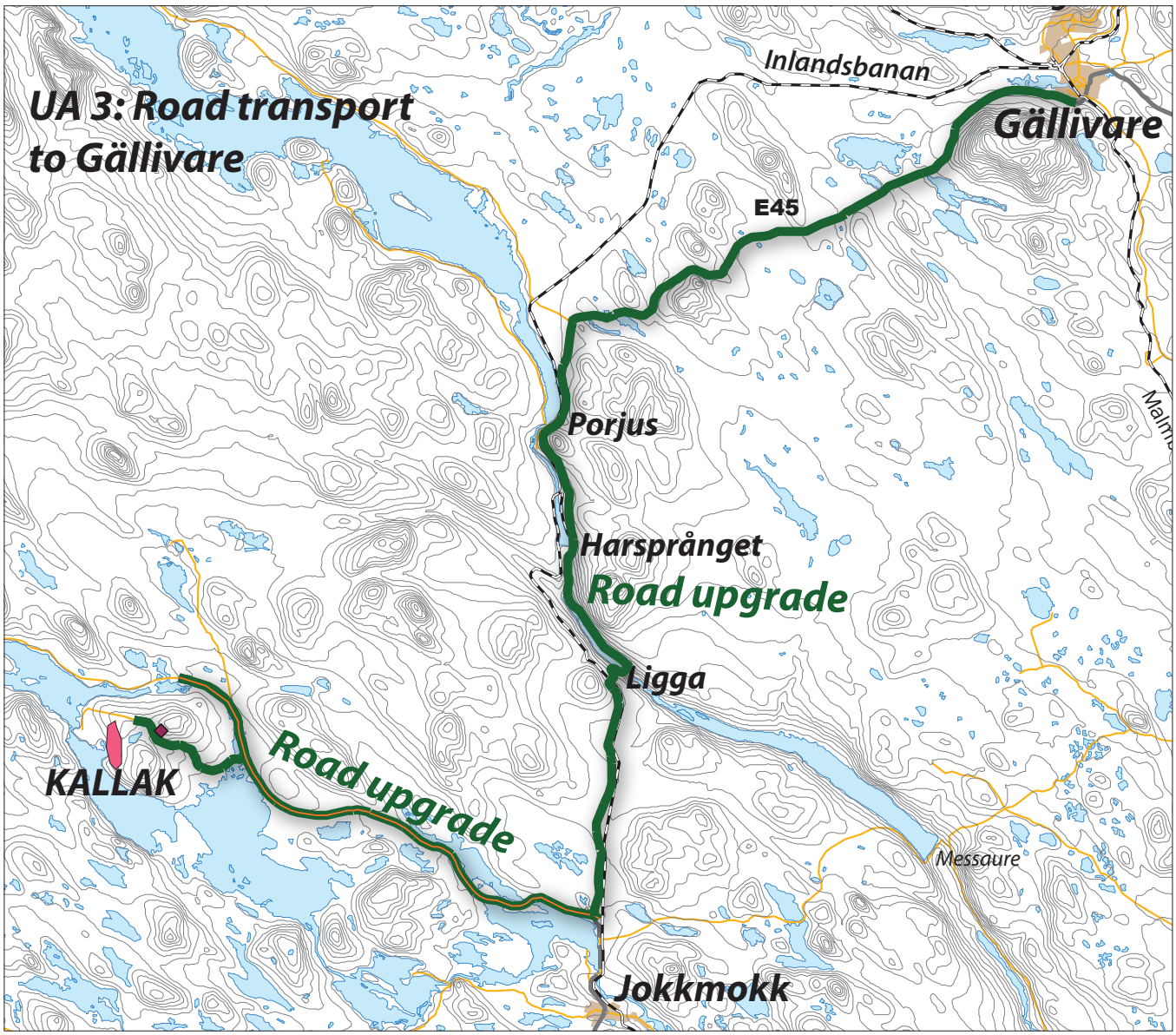


Figure 4.4:1 Lorry all the way to Gällivare.

4.5 Impacts of the freight transports

Dense traffic with heavy lorries has greater environmental impact in comparison to rail.

The wear on the road network is also significantly larger. There is no experience yet on how the extra heavy lorries will wear on the road network. Heavier lorries are likely to cause more wear, which is partially compensated for by fewer transports.

4.6 Implications for and by passenger transports

Passenger transport by rail is facilitated and secured, if any of the railway alternatives are built.

Although the alternatives with lorry transports include some road investments, the frequent lorry traffic will cause disturbances in form of delays for other traffic, noise and wear.

The accessibility on the road network will be affected by the large number of heavy lorries that will run on the roads.

4.7 Commuting

Commuting flows to/from the mining operation will largely depend on where housing contributions are made.

In case the majority of the 400 mining employees reside in Jokkmokk, it will be easy to supply the mine with public transport. In addition, Jokkmokk's service supply will get a considerably improved basis, particularly if families move in to a large extent.

If barrack accommodation is established near the mine, commuting journeys will be shorter, however, service will not be suported as desired, since most of barrack accommodation tends to be of character "fly in - fly out" without accompanying families.

Distances from Vuollerim and from Porjus to Kallak are so long that daily commuting is only to be expected to a very limited extent.

In case UA1 Väst ("West") or UA1 Gen ("Short") is built with a parallel service road, this can with some broadening allow for convinient daily commuting Porjus - Kallak.

4.8 Costs of the alternatives

Cost calculation is at this stage rough, as detailed information is lacking on the geotechnical conditions and the current condition of the Inlandsbanan line.

All variations of UA1 involve high investment costs, since new railway is built between Kallak and the Inlandsbanan line.

A rough cost estimate has been made for six different studied alternaties. The costs are in current prices (2012-09).

The investment cost for the upgrade of the Inlandsbanan line contains uncertainties concerning the railway's present condition. A more advanced study is needed to increase the accuracy of the calculation.

The railway alternatives Kallak-Gällivare have relatively similar investment costs. In this stage of investigation, the differences are within the margins of error.

UA1 Syd ("South") has the highest total cost of the railway alternatives, around SEK 4.4 billion. UA1 Gen ("Short") and UA1 Mitt ("Mid") cost slightly less, around 4.2 billion. UA1 Väst ("West") has the lowest cost of the railway alternatives, around 3.9 billion.

The alternatives with lorry traffic to a terminal by the existing railway involve significantly lower investment costs, but also significantly lower social benefits. UA2 costs around SEK 2.9 billion and UA3 only around SEK 1.3 billion. The cost of UA2 and UA3 include efforts to prepare for the extra reloading required between road transport and rail transport. In these calculations, this cost is estimated to around SEK 200 million.

Inlandsbanan AB has identified a need to upgrade Arvidsjaur-Gällivare to 22.5 tonnes axle load. This is to allow for other freight transports along the Inlandsbanan line. According to Inlandsbanan AB this costs around SEK 550 million for the route Arvidsjaur - Gällivare. Since the Inlandsbanan line is not upgraded to 30 tonnes axle load in UA3, the upgrade to 22.5 tonnes axle load is needed. The cost is evenly distributed along the route, which corresponds to around SEK 200 million in UA3 for the part that is upgraded in UA1 and UA2. UA3, ie lorry transport Kallak-Gällivare, has the lowest construction costs.

Heavy lorries can be affected by steep gradients resulting in lower speeds uphill and can disrupt the flow of traffic for other road users but with the low intensity of traffic on the E45, it should not be a major problem. In particularly severe inclines, there may still be a need for investment in climbing lanes or to reduce road gradient, measures that increase the cost of upgrading the road. The gradient problems are only on road E45. On road 805 there are no problems concering gradients.

The costs of the different variations of UA1 are slightly different but the differences are not so great that the ranking between variations may not change following more advanced cost calculations in future study phases.

	Total	New railway	Upgraded Inlandsb.	Road
UA 1 West	3900	2400	1500	0
UA 1 Short	4200	2700	1500	0
UA1 Mid	4200	2300	1900	0
UA1 South	4400	2300	2100	0
UA2	2900	300	2200	300
UA3	1300	200	200	900

Figure 4.8:1 Table of cost estimates in million SEK for the six studied alternatives. The cost of new railway in UA2 is higher than in UA3 as a result of the triangular junction in Gällivare.

4.9 Cost-Benefits Analysis

The estimated socio-economic benefit of the alternatives based on a 40-year calculation period. The mining operations may last much longer than that. Today, estimated volume lasts about 60 years. The discount rate is 3.5% for the society and 5% business economically (according to the Swedish Transport Administration's guidelines). Since there is no realistic alternative for comparison, the different study alternatives are compared to each other. Having the least cost of investment in infrastructure, UA3 here works as the alternative to which the other alternatives are compared (see Figure 4.9:1).

UA1 in all variations is clearly the most expensive investment, but give the best socio-economic benefits.

UA1 Väst ("West") will be the best alternativ, around SEK 1.4 billion better than UA3. UA1 Gen ("Short") and UA1 Mitt ("Mid") is SEK 1.0 to 1.1 billion better than UA3. UA1 Syd ("South") will be about SEK 0.7 billion better than UA3 and UA2 will be around SEK 0.6 billion better.

The major benefit lies in the differences in transport costs, but also the environment and safety matters.

It is likely that the mine will live longer than 40 years or that other deposits nearby can contribute to the corresponding volumes. Longer operation time strengthens the UA1 alternatives further.

	UA1 West	UA1 Short	UA1 Mid	UA1 South	UA2	UA3
Construction Cost	*2600*	*2900*	*2900*	*3100*	*1600*	*0*
Of which rail	*3500*	*3800*	*3800*	*3900*	*2100*	*0*
Of which road	*-900*	*-900*	*-900*	*-900*	*-500*	*0*
Socio-economic calculus (price level 2010)	2400	2700	2700	2800	1400	0
Residual value	500	500	500	500	300	0
Effect for infrastructure management	-140	-160	-160	-170	-85	0
Effect for mining operator	2800	2800	2700	2600	1400	0
Effect for other customers	++	++	++	++	++	0
Of which rail	-800	-800	-900	-1000	-700	0
Of which road	3600	3600	3600	3600	2200	0
Environment and safety	2100	2100	2100	1800	1100	0
Taxes	-1000	-1000	-1000	-1000	-600	0
SUM OF BENEFITS	3700	3700	3600	3600	2000	0
NET PRESENT VALUE	1400	1100	1000	700	600	0

Figure 4.9:1 Socio-economic calculus in million SEK for the six studied alternatives. UA1 Väst is in this prel investigative stage best from an economic point of view, followed by UA1 Mitt and UA1 Gen. The lorry alternative UA3 is the least socio-economically favourable.

Transport costs – The mining operator

The annual difference in transport costs for the mining operator on the part carried by rail varies slightly between all UA1 and UA2. UA1 has rail transport costs between SEK 48-60 million per year. For UA2, the equivalent cost is around SEK 45 million per year.

UA2 and UA3 have large annual costs for lorry transports, see Figure 4.9:2. UA3 is clearly the most expensive by nearly SEK 200 million per year. UA2 costs around SEK 78 million per year.

The road transport costs are based on data on costs and service costs for the 90-tonne lorries with estimated fuel consumption from a manufacturer's data. Other expense items are taken from the Swedish Transport Administration and ASEK5. (ASEK stands for working group for cost-benefit calculation and analysis in the transport sector. ASEK is led by the Swedish Transport Administration.) Railway costs consist of operating costs depending on length and time. In addition, track fees are included. Transportation costs include eg. no items regarding interference risks or benefits for the seller.

UA1 means, in all cases, significant cost savings by between SEK 2.6 and 2.8 billion compared to the alternative with lorry to Gällivare (UA3). UA2 means around SEK 1.4 billion lower transport costs than UA3.

Effects for other customers

The effects for other customers on the railway will be positive for the traffic that will use the Inlandsbanan line. Today, traffic is limited but opportunities for different industries are created if the railway standard is increased.

The improvements provide added value for passenger traffic, but more importantly, they allow for new freight transport arrangements and improve conditions to redirect some freight transports in case of disruptions on the Main Line or on the Malmbanan line.

Environment and safety

This item with so-called externalities include for instance infrastructure costs such as wear, accidents, carbon emissions, other air pollutants and noise. UA3 means many lorry transports over long distances and is thus the worst alternative from this point. UA1 in all variations mean around SEK 1.8 billion better result than UA3. UA2 is around SEK 1.1 billion better than UA3.

Tax

Large parts of wear and environmental impact are covered by taxes. Tax incomes will be highest with UA3 and lowest in the railway alternatives, see figure 4.9:1.

Residual value

Since the Inlandsbanan line will be used during a period longer than 40 years and the mining deposits can last for 60 years or longer, the investment will have a value after the calculation period ends. This has not been given closer consideration in the socio-economic assessment. The residual value benefits all variations of UA1 and UA2.

	UA1 West	UA1 Short	UA1 Mid	UA1 South	UA2	UA3
Transportation cost /year	*49*	*48*	*57*	*59*	*123*	*194*
Of which rail	*49*	*48*	*57*	*59*	*45*	*0*
Of which road					*78*	*194*

Figure 4.9:2 Table of the difference between the alternatives annual transport costs for road and rail for the part between the mine and Gällivare in million SEK.

4.10 Evaluation of alternatives

Evaluation of the alternatives include goal achievement, cost-benetif analysis, risk issues, conflict areas, etc.

Alternative UA1 Väst ("West") is the alternative that provides the greatest benefit to society and simultaneously means good business economic conditions and little impact on the climate.

Other UA1 alternatives have similar characteristics. More detailed cost estimates in future phases may to some extent change the order of some of the alternatives.

For all UA1 alternatives, the time schedule is important for it to be possible to transport the ore already in 2018.

There are several Sami villages in the area where the new rail line could be envisaged. This has been taken into account in the design of alternatives. UA1 Syd ("South") largely follows road 805, which means less intrusion. The tunnel in UA1 Gen ("Short") also facilitates for the reindeer industry.

The combined lorry and rail option UA2 is clearly worse than any versions of UA1 in most aspects, although the investment cost is lower. An advantage may be that UA2 has a shorter implementation time.

UA3 has the lowest construction cost and probably the shortest implementation time.

UA3 has, however, clearly the highest transport costs. The transports furthermore becomes more expensive if exemption for the 90 tonne lorries is not granted. One possible obstacle to an exemption can be gradient problems along road E45. It may be that an exemption can be granted if the road is adjusted for heavier transports with climbing lanes and some new routes. That would increase the cost of road investments, while transport costs remain almost unchanged.

Economic, ecological and social aspects speak for UA1.

The fastest alternative to complete is UA3 and all studied alternatives contain certain risks that may affect how fast the measure is completed or affect costs and benefits of alternatives.

	UA1 West	UA1 Short	UA1 Mid	UA1 South	UA2	UA3
Economy, the mine						
Ekonomy, the society						
Ecological sustainability						
Social sustainability						
Rapid completion						
Risks						

Figure 4.10:1 Evaluation matrix

5 Suggested focus and recommended actions

5.1 Description of the overall focus

A rail solution is recommended for the entire distance between Kallak and Gällivare.

5.2 Recommended measures

The knowledge base needs to be improved in terms of the standard of the Inlandsbanan line and the cost of upgrading it to premissable axle load (STAX) 30 tonnes and 12 tonnes of weight per meter.

Further studies are needed to clarify any limitations due to gradients.

5.3 Recommendation for planning at the project level

For the continued planning it is recommended that:

- Four alternatives are given in-depth studies
- Aerial photography of the concerned routes, to obtain satisfactory map data
- Geotechnical investigations of selected routes

5.4 Suggestions fore decision making

In-depth studies are suggested for UA1 Väst (West), UA1 Gen (Short), UA1 Syd (South) and UA2.

Measure priority study

Ore transports between the Kallak Mine and the Malmbanan line