ARCTIC RAILWAY

23rd February 2018

Preface

This report is part of the cooperative effort between Finland, Sweden and Norway to investigate the potential and feasibility of an improved or new railway connection to a harbour in Northern Norway, the Arctic Railway.

Norconsult has produced this report for its client the Norwegian Railway Directorate (Jernbanedirektoratet) to assist the Finnish consultants engaged by the Finnish Transport Agency (Liikennevirasto) to assess the viability and potential of such an Arctic Railway.

The Norconsult team working on the project included Thomas J. Potter (Project manager), Hans Petter Duun, Frode Voldmo, Kristina Ebbing Wensaas, Henning Thauland, Kaare Stjern and Ingunn Maria Thorbergsdottir.

The Project manager for the Norwegian Railway Directorate was Hanne Dybwik-Rafto.

Bergen

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1 Introduction

1.1 The project

The Finnish Transport Agency (Liikennevirasto) together with Norwegian railway authorities have decided to explore the possibilities for constructing the Arctic Railway and to examine its profitability. A new railway project would help Finland and Norway take advantage of melting sea ice in the Northeast Passage between Asia and Europe, by shipping products from the Arctic coast.

1.2 The consulting team

Norconsult has been engaged by the Norwegian Railway Directorate to assist and cooperate with the Finnish Transport Agency and their consultants (Rambøll Finland and SITO) on a feasibility study for a rail connection from Finland to a transhipment harbour in Norway.

This study has been requested by the Finnish Ministry of Transport and Communications.

1.3 Areas of responsibility

In general, Norconsult has responsibility for the areas where the railway is planned through Norway.

More specifically, Norconsult has been tasked with providing specific information to the two Finnish consulting teams.

Rambøll Finland is responsible for the following topics:

- The general concept of using the Northeast passage as a faster and possibly more economic route between Asia and the Nordic countries as well as Europe
- The economic case for building a rail connection to a harbour in Norway
- The costs of infrastructure with the construction of new rail lines and new harbour facilities or upgrading of existing lines and existing harbour facilities

SITO is responsible for the following topics:

- Impacts on the environment
- Technical considerations of the proposed rail line including technical standard
- Preliminary cost estimates of various alignments based on topography and the feasibility of specific construction requirements (tunnels, bridge, escape routes)

2 Situation in Norway

2.1 Road

In Northern Norway, the connecting projects on E6 in Helgeland will provide good road standards south of Saltfjellet. The Government's commitment to E10 will improve the road connection for both Vesterålen and Lofoten. In Nordland and Troms, improvements will be made on key mountain passes. With the completion of E6 west of Alta, E6 will generally have a good standard in Finnmark. Development of E105 will improve the connection between Kirkenes and Russia.

There is still a great need for resources to catch up with the backlog of maintenance on the road network and associated upgrades. The condition of the county road network is poor in many places.

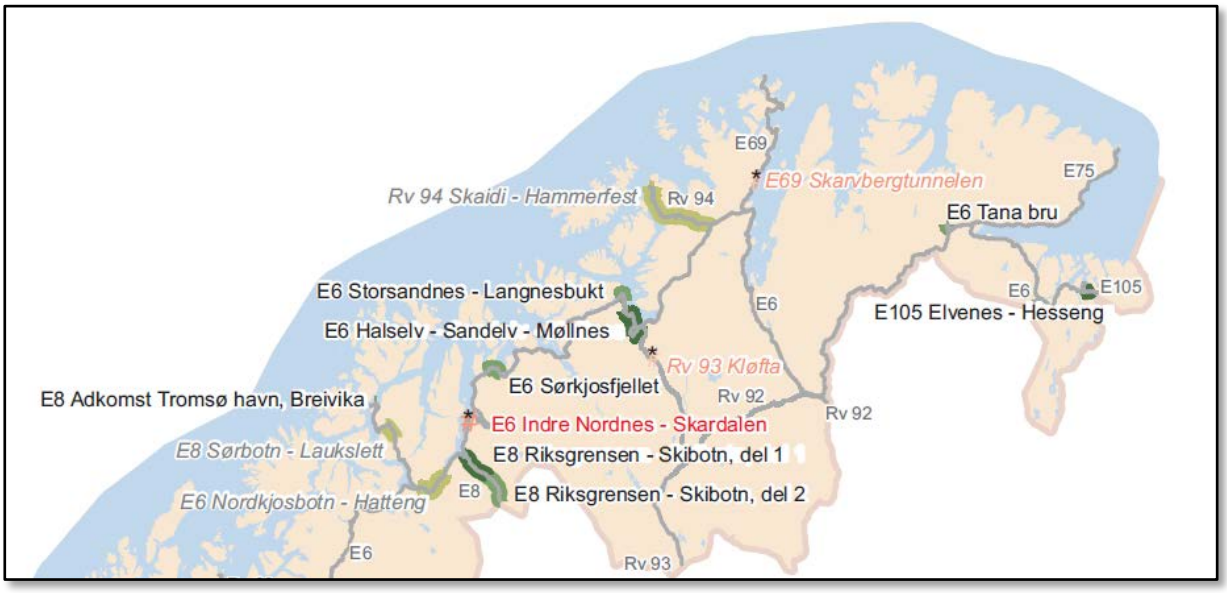

Figure 1: Road projects in Northern Norway 2014–2023.

2.2 Rail

2.2.1 The Ofoten Line (Ofotbanen)

The existing rail network in Northern Norway is limited to the Ofoten Line (Ofotbanen), a 43-kilometre railway line between the Swedish border and the harbour city of Narvik. At the Swedish border, the line continues as the Iron Ore Line (Malmbanan) in Sweden, via Kiruna and Gällivare to Luleå.

The Ofoten Line is single track, standard gauge of 1435 mm, electrified at 15 kV 16 2⁄3 Hz AC and has seven stations. It has an average gradient of 21‰ and a maximum gradient of 25‰. There are 5 bridges, 18 tunnels and 8 level crossings on the line. The Norwegian National Transport Plan sets aside funds for measures to increase the capacity of the Ofoten line.

The Ofoten Line only connects to the rest of the Norwegian railway network via Sweden. The main traffic is up to twelve daily freight trains operated by Malmtrafik that haul iron ore from Sweden to Narvik. In addition, CargoNet operates container trains, branded as the Arctic Rail Express (ARE), and The Swedish Railway (Statens Jernvegar, SJ) operates passenger trains, including a night train between Narvik and Stockholm. The Ofoten Line is also part of the Northern East West Freight Corridor, which hauls containers from China and India to North America.

Construction of the Ofoten Line started in 1898 along with the Iron Ore Line from Riksgränsen on the Norway-Sweden border to Kiruna. They were completed in 1902, allowing the mining company LKAB to haul ore from their mines in Kiruna to the ice-free Port of Narvik. Operation and ownership of the line was held by the Norwegian State Railways. The line was electrified in 1915. During World War II, the ore traffic stopped because of the battles of Narvik and the bombing of the town.

In 1996, operation of the ore trains was taken over by Malmtrafik, which was controlled by, and now is a subsidiary of, LKAB. The same year, ownership of the railway line was transferred to the newly created Norwegian National Rail Administration (Jernbaneverket). The line has been upgraded to 30 tons (30 long tons; 33 short tons) axle loads, allowing new locomotives to haul 8,600 tons (8,500 long tons; 9,500 short tons) trains.

In 2013, Jernbaneverket (now Bane NOR) completed a double-track investigation that looked at possible concepts and challenges connected with doubling of the capacity from Sweden to Narvik. The recommended solution was the construction of a new single track in 3 sub-sections and an axle load of 40 tons. Finally, the recommendation of the concept and alignment of the Ofoten railway was adopted by Jernbaneverket in December 2015. Increased axle loads on the current track is only applicable when the equivalent is performed on the Swedish side.

The cost of this project is estimated to be between 10 and 15 billion NOK.

2.2.2 The Northern Norway Line

There have been discussions in Norway for many decades about the possibility of building the Northern Norway Railway (Nord-Norgebanen). This line is a proposed railway which would be built through Northern Norway. Several proposals have been made: 1) to connect from the Nordland Line at Fauske and continue onwards to Narvik, Tromsø and Harstad and 2) the Troms Line (Tromsbanen). The latter is a more limited proposal, which calls for a line between Narvik and Tromsø, but which would not connect to the rest of the railway network in Norway and instead the Swedish railway network via the Ofoten Line. During the Second World War, the German occupation forces began construction of a Polar Line between Fauske and Narvik, but that was abandoned.

2.2.3 The Arctic Railway

The Arctic Railway is specifically mentioned in the Norwegian National Transport Plan for the period 2018 – 2029. [1]

> *There are a number of initiatives for new border-crossing rail connections from Sweden, Finland and Russia to ice-free Norwegian ports. If there is a clear interest from government authorities and industrial players in neighbouring countries to go ahead with a new freight line, the Government in Norway will be open to participate.*

2.3 Sea transport and harbours [2]

2.3.1 Narvik

Narvik is located on the Ofotfjord and has a population of approximately 19.000 inhabitants. The port of Narvik is ice-free and well protected from the weather. The port consists of three waterfront sections: LKAB bulk port, central port area with piers, and a deep-water harbour at Fagernes with intermodal facilities.

Approximately 16 million tons of cargo are annually shipped from the ports of Narvik. By 2015, the port had handled 1.1 billion tons of ore during its history. The Narvik Port Authorities have initiated an expansion of the container area of approximately 45,000 square metres (11 acres), which is more than twice what Norway's largest terminal in Oslo handles today.

2.3.2 Skibotn

Skibotn is a village in the municipality of Storfjord in Troms county, Norway. It is located on the south-eastern shore of the Lyngen fjord in Northern Norway. The village area is located at the crossroads of the European route E6 and European route E8 highways. It has a population of approximately 570 inhabitants.

[1] The Norwegian National Transport Plan: https://www.ntp.dep.no/English
[2] Data and description of harbours taken from Wikipedia.

2.3.3 Kirkenes

Kirkenes is located in the extreme north-eastern part of Norway on the Bøkfjord, a branch of the Varangerfjord, near the Russian border. The city and harbour are 400 kilometres north of the Arctic Circle and as far east as St. Petersburg. The approximately 7,000 inhabitants are of Norwegian background, while a minority is Sami. Others originate from Finland and Russia.

Kirkenes is also the terminus of the Kirkenes–Bjørnevatn railway, the world's second-most northerly railway line, used to transport iron ore from the mines at Bjørnevatn to the port at Kirkenes. It has a length of 8,5 kilometres.

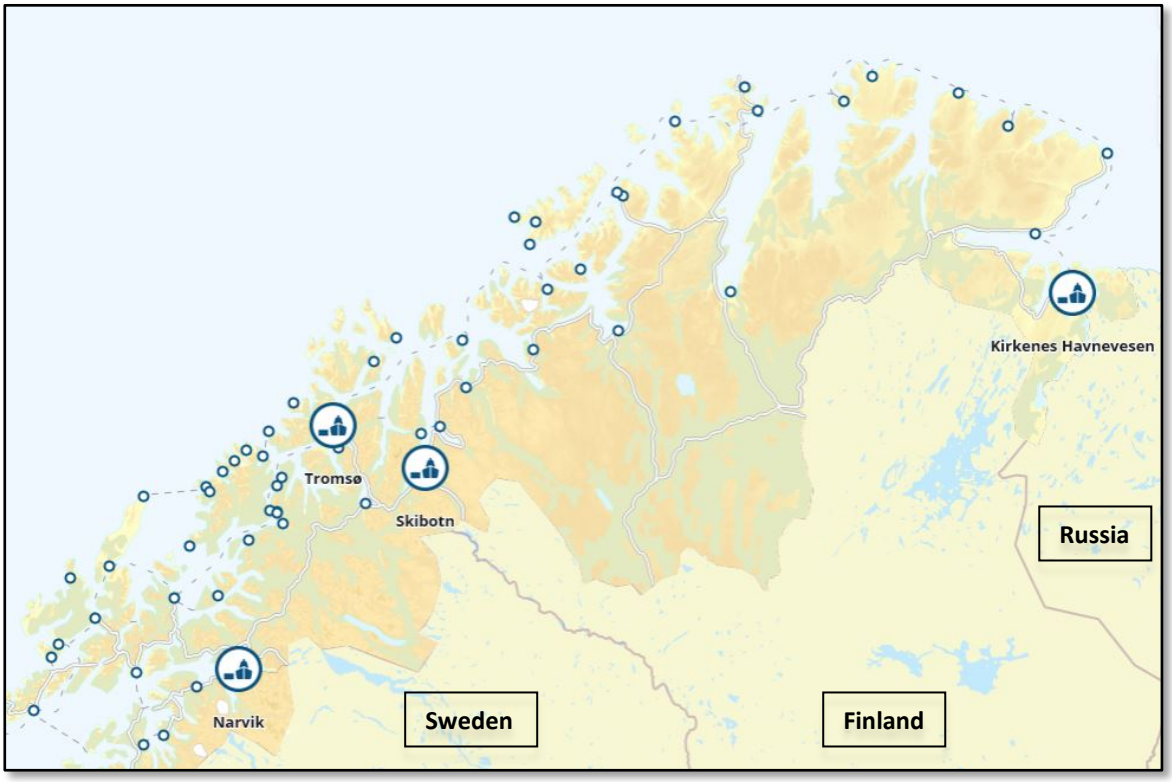

Figure 2: Map showing the three harbour areas (Narvik, Skibotn and Kirkenes) and Tromsø in Northern Norway.

2.4 Barents Euro-Arctic Transport Area (BEATA)

The transport system in the High North should be developed in a coordinated and comprehensive manner. Norway has consequently taken the initiative through the Barents cooperation to develop a cross-border strategy that sets out how the transport system in the High North should be developed. An expert working group has been established with representatives from the transport authorities in the four Barents Sea countries to prepare a proposal for a common Barents Sea transport plan. During 2013, the transport ministers proposed principles for a long-term development of the transport system in the north on the basis of the recommendations of the expert working group.

2.5 Viewpoint of stakeholders

2.5.1 Interest group meeting – Tromsø – 16th January 2018

The Norwegian Railway Directorate arranged an interest group meeting in Tromsø on the 16th of January 2018 to gather relevant information and input for the study. Counties, municipalities, Norwegian state agencies, the Sami Parliament and businesses where invited to participate and give presentations.

Among the attendees were representatives from Balsfjord municipality, Sør-Varanger municipality, Storfjord municipality, Tromsø municipality, Finnmark county, Troms county, Nordland county, the county governor of Troms, the Finish Transport Administration, the Norwegian Public Roads Administration, the Norwegian Coastal Administration, the Sami Parliament of Norway, the Swedish Transport Administration, the Norwegian Ministry of Transport and Communications, LKAB Malmtrafik AB, Narvik Port KF, Norconsult, Futurum and Tornedalsrådet. The majority of these also gave presentations.

After the meeting the Norwegian Railway Directorate received written inputs from 6 stakeholders: Futurum AS, Kirkenes næringshage, the Norwegian Coastal Administration, Narvik Port KF, Storfjord municipality and Tromsø municipality. The inputs consisted of letters, as well as previous reports on the Arctic Railway, the Ofoten Line, the transport needs in the Barents region, and the potential for development in the northern regions.

The inputs during and after the meeting suggest that there is a significant interest in the Arctic Railway, but the stakeholders' opinions on the most beneficial route for Norway differ among them according to what areas they represent.

2.5.2 Orientation meeting with the Norwegian Sami Parliament

On the 29th of January the Norwegian Railway Directorate held an orientation meeting with the Norwegian Sami Parliament, with Norconsult present. The attendees from the Sami Parliament represented interest areas including business, culture and conservation, health, land use and environment.

Due to the short notice and early stage in a possible planning process, the feedback from the Sami Parliament was focused on the further process and requirements concerning Sami interests. Important issues were mapping and inclusion of relevant Sami stakeholders; accumulated

consequences for Sami industries such as reindeer herding, agriculture, fishing and harvest; competence about Sami interests in the planning and evaluation work; and mapping and registering of Sami cultural heritage sites and environments. They also stressed the importance of a collaboration between the different Sami Parliaments in Norway, Sweden and Finland.

2.5.3 Overview of written inputs

Stakeholder	Description of stakeholder	Type of inputs	Conclusion of input
Futurum AS	Industry development company in Narvik	Letter: Input to the Arctic Railway White paper: National Transport Plan 2018-2029. Ministry of Transport and Communication. Report: "A Railway Corridor for the Future – An Analysis of the Societal Benefit of the Ofoten Line". 2015. Ofotbanealliansen, Sitma and Nordland county. Report: "Joint Barents Transport Plan." 2013. The Barents Euro-Arctic Region. Leaflet: "The Ofoten Line". Ofotbanealliansen, Sitma and Nordland county.	In favour of the routes Kolari-Narvik and Tornio-Narvik.
Kirkenes næringshage, Sør-Varanger utvikling and Finnmark county	Co-operation between industry development companies in Kirkenes and Sør-Varanger municipality, and Finnmark county	Report: An Arctic Railway vision – The goods perspective for an Arctic railway between Rovaniemi and Kirkenes, linking to a port on the Barents Sea" (both English and Norwegian report). 2018. Kirkenes næringshage, Sør-Varanger utvikling and Finnmark county.	In favour of the route to Kirkenes.
The Norwegian Coastal Administration	Agency of the Norwegian Ministry of Transport and Communications responsible for services related to maritime infrastructure ++	Letter: Inputs from the Norwegian Coastal Administration – Feasibility study Arctic Railway. 23rd January 2018 Excerpt from report: "Maritime Infrastructure Svalbard, Finnmark, Troms and Nordland – Possible fairways for large ships". 2011. Barlindhaug Consult.	Positive to a future railway that will lead to connections between freight by sea and rail. Information on port infras-tructure, but no recommendation based on this.

Narvik Havn KF	Municipal company responsible for administrating, planning and promoting the Narvik port	Letter: "Inputs from Narvik Havn KF to the evaluation of the Arctic Railway" 22nd January 2018. Report: "Barents Railway Network – Needs study". 2005. ÅF-Infraplan AB and JICL Johnsson AB Presentation: Sustainable Transport in the Barents Region, Pre-study. Björn Winqvist, EP Consulting. 2004.	In favour of the route to Narvik based on its existing infrastructure and potential.
Tromsø Municipality		Letter: "Inputs to feasibility study Arctic Railway" 23rd January 2018. Attachment: The Arctic Railway West. Tromsø Municipality Report: The Arctic Railway West Marked Potential and Possibilities. Kolari – Muonio – Kilpisjärvi – Skibotn. 2011. Rambøll. Report: The Arctic Rail Feasibility Study, Railway Kolari – Skibotn. 2009. Sweco.	In favour of the route to the Tromsø region.
Storfjord municipality		Letter: "Inputs from Storfjord municipality about a railway in the North". 22nd January 2018 Leaflet: Ishavsbanen final version 040213 Input from Tornedalsrådet: Ishavsbanen. Introduction document: Ishavsbanen 2010. Transportutvikling AS. Report: The Arctic Rail Feasibility Study, Railway Kolari – Skibotn. 2009. Sweco. Report: Ishavslei, Universitet I Tromsø, 2010	In favour of the route to the Tromsø region (Ishavsbanen vest)
The Sami Parliament, Norway		Letter: "Concerning Arctic Railway". 2nd February 2018	Need for further involvement and consultation in future process.

3 Basis for alternatives

3.1 Technical design parameters for Arctic Railway

Railway	single-track automatic block signaling centralized traffic control automatic train control passenger-and-freight railway
Electrification	yes
Train-passing	siding tracks for passing every 30 km; each with its own interlocking
Rails	60 E 1
Thickness of frost-resistant bearing structures	2,600 mm
Standard cross-section	Jk-1-PB-2600-6,8 [1] Jk – continuous welded rail 1 – single track P - embankment B – concrete sleepers 2600 – bearing-course thickness 2,600 mm 6,8 – embankment width 6,8 metres
Design speed for non-tilting trains	200 km/h
Minimum horizontal curve radius	2 500 m
Design axle-load	300 kN (maximum speed 100 km/h)
Maximum gradient	12.5 ‰
Slope section length using maximum gradient	600 – 2 000 m
Minimum vertical curve radius	2 000 m
Maximum ballast height	approx. 10 m
Maximum cutting depth	approx. 25 m (short tunnels to be avoided)
Culverts	1 per kilometre
Level crossings	none with public roads

3.1.1 Comment on design parameters

The maximum gradient of 12,5‰ will be difficult to achieve along the Norwegian segments of the railway. For example, the height of the railway at the Norwegian-Finnish border for alternative 2 is about 500 metres and the distance to Skibotn is only about 40 kilometres. A rise of 500 metres in 40 kilometres is the maximum gradient of 12,5‰. It will be impossible to have the maximum gradient less than or equal to the average gradient over such a long section.

The Ofoten Line has an average gradient of 21‰ and a maximum gradient of 25 ‰.

3.2 Track gauge

The Norwegian and Swedish railway operate with a track gauge of 1435 mm (4' 8 ½ "). The Finnish gauge is 1524 mm.

The assumption is that the rail connection to Narvik will be standard gauge as it will be based on the existing infrastructure. Alternatives based on completely new rail alignments to Skibotn/Tromsø and Kirkenes are naturally considered as extensions of the existing Finnish rail network and would be built based on Finnish design standards, including a gauge of 1524 mm.

4 Description of alternatives

4.1 Overview of alternatives

The Finnish Transport Agency is investigating five possible alternatives.

1. Tornio – Haparanda – Kiruna – Narvik
2. Kolari – Kiruna – Narvik
3. Kolari – Skibotn / Tromsø
4. Rovaniemi (Kemijärvi) – Kirkenes
5. Rovaniemi – Kemijärvi – Murmansk

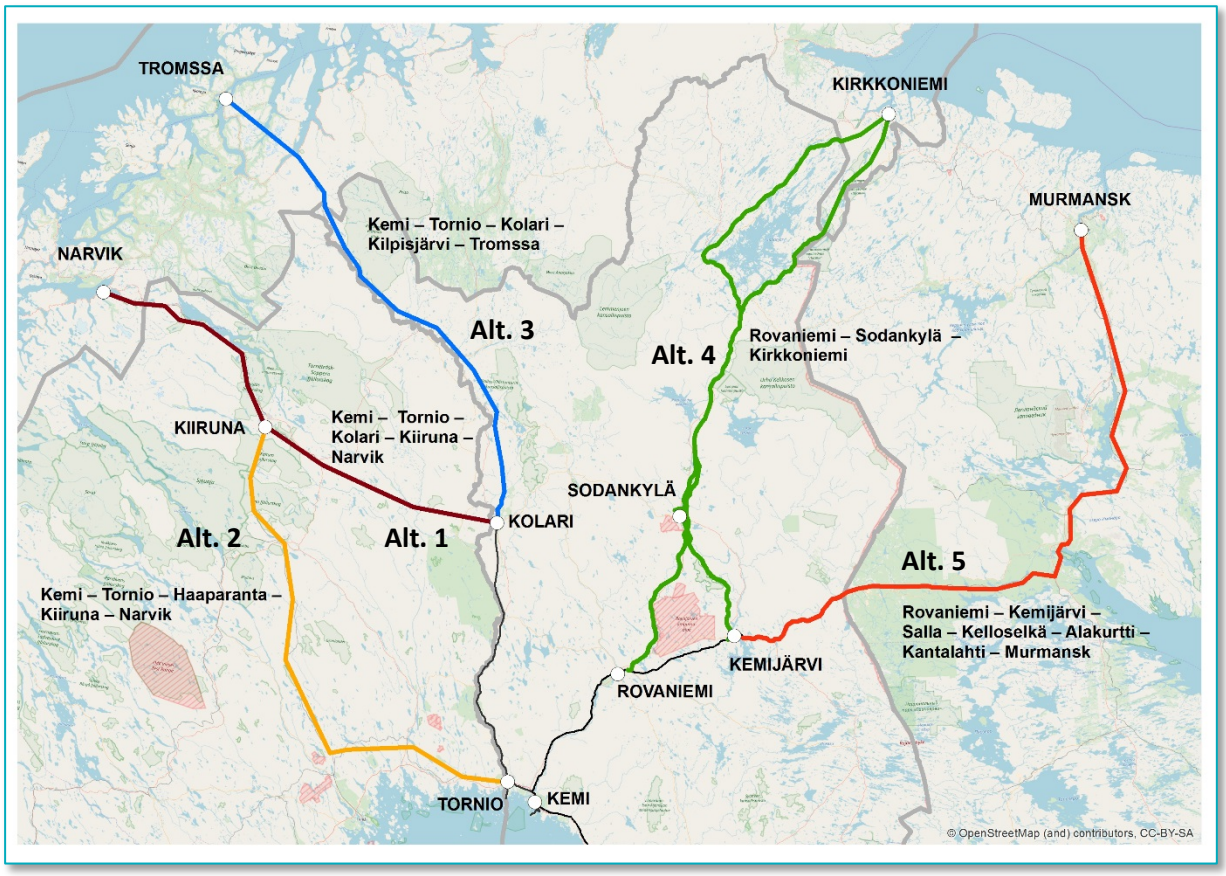

Figure 3: Alternative alignments for Arctic Railway.

4.2 Alternative 1: Via existing Malmbanan / Ofotbanen to Narvik

There are two variants to this alternative. Both are based on the use of existing rail infrastructure in Finland, Sweden and Norway.

The first, Alternative 1A, crosses the border from Finland to Sweden at Tornio/Haparanda and continues on to Kiruna and a connection with the Iron Ore Line and the Ofoten Line to Narvik via Gällivare.

The second variant, Alternative 1B, continues north from Tornio and branches from the Finnish rail network at Kolari and then to Kiruna and Narvik.

Alternative 1A

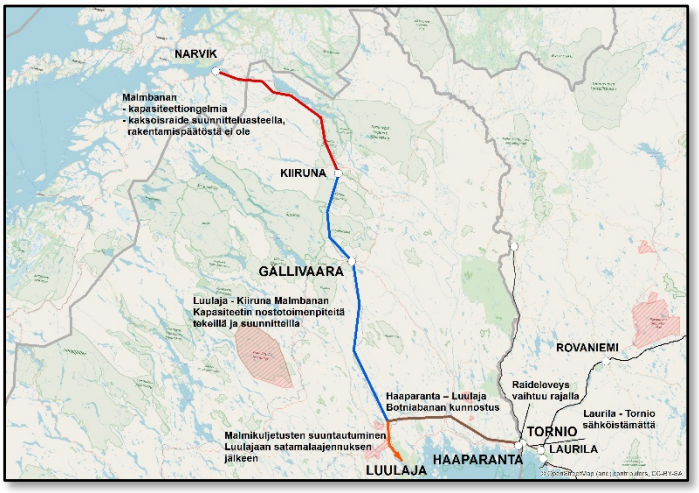

Figure 4: Alternative 1A: Tornio - Narvik via Haparanda and Gällivare.

Alternative 1B

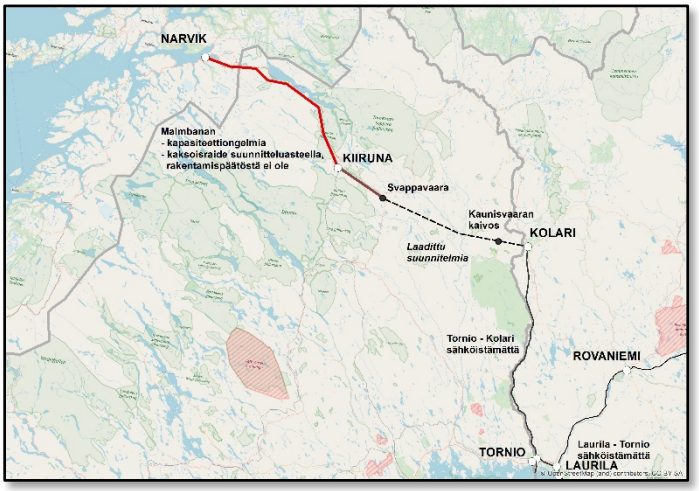

Figure 5: Alternative 1B: Tornio - Narvik via Kolari.

4.3 Alternative 2: New line from Kolari (SE) to Skibotn / Tromsø

Figure 6: Alternative 2: Kolari - Skibotn / Tromsø.

4.4 Alternative 3: New line from Rovaniemi to Kirkenes

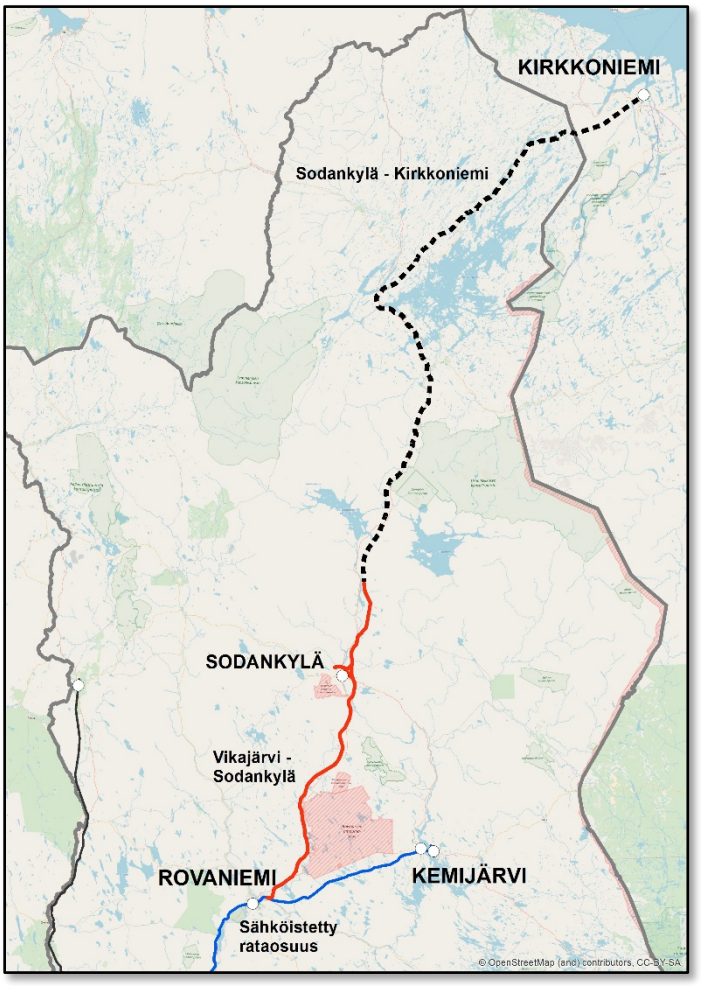

Figure 7: Alternative 3: Rovaniemi – Kirkenes.

5 Infrastructure cost estimate

5.1 Assumptions for cost estimates

5.1.1 Track infrastructure unit costs

The cost estimates are based on the following unit costs per kilometre of track including all costs for design, project supervision, rigging and testing.

Table 1: Unit costs per kilometer.

	Embankment / cut	Bridge	Tunnel
Million NOK / km	146	578	462
Million EUR / km*)	15	60	48

*) Costs in EUR are based on an exchange rate of approximate 9,68 NOK / EUR.

5.1.2 Harbour costs

It is estimated that the construction of suitable harbour facilities in Norway for the Arctic Railway will cost approximately 5000 million NOK. This estimate is valid until more detailed investigations can be made. It covers both all potential new sites (Skibotn and Kirkenes) as well as upgrading the harbour at Narvik.

5.2 Alternative 1: Tornio – Kiruna – Narvik

The cost of upgrading the Ofoten Line to double track is estimated to be between 10 and 15 billion NOK. The need for such an upgrade is based on existing and anticipated market conditions for the transportation of iron ore from Sweden to Narvik. The upgrade is a necessary element in order for the Arctic Railway to use the connection via Sweden (Kiruna) to Narvik.

The improvement costs for Narvik harbour are estimated at 5000 million NOK. It may be possible to improve the existing harbour facilities for use by the Arctic Railway for a smaller amount of investment. However, until a more exact analysis is made of the needs for the Arctic Railway and the capacity and scope of the existing or planned improvements of the Narvik harbour, this conservative estimate of the costs is proposed.

Table 2: Cost estimates, Alternative 1 to Narvik.

	Ofotbanen	Harbour	Total
Cost (Mill. NOK)	10 000	5000	15000
Cost (Mill. EUR)	1040	520	1560

5.3 Alternative 2: Kolari – Skibotn / Tromsø

The cost estimates below are based on a preliminary rail alignment from the Finnish border to Skibotn.

Table 3: Cost estimates, Alternative 2 to Skibotn.

	Embankment / cut	Bridge	Tunnel	Harbour	Total
Border – Skibotn	23,1 km	1,6 km	20,3 km		45,0 km
Cost (Mill. NOK)	3373	925	9379	5000	18 676
Cost (Mill. EUR)	347	96	974	520	1937

The additional cost of building the railway line further to Tromsø from Skibotn is shown below. The unit costs for daylight track are higher for this parcel due to the difficult topography. A unit cost of NOK 231 000 / m (24 000 EUR / m) has been used.

Table 4: Cost estimates extension Skibotn – Tromsø.

	Daylight	Bridge	Tunnel	Harbour	Total
Skibotn – Tromsø	62,5 km	3,5 km	35,9 km		103,9 km
Cost (Mill. NOK)	13 236	2023	16 586		31 845
Cost (Mill. EUR)	1367	209	1714		3290

5.4 Alternative 3: Rovaniemi - Kirkenes

The cost estimates below are based on a preliminary rail alignment from the Finnish border to Kirkenes.

Table 5: Cost estimates, Alternative 3 to KirkenesTable 4: Cost estimates, Alternative 3 to Kirkenes.

	Embankment / cut	Bridge	Tunnel	Harbour	Total
Border – Kirkenes	25,7 km	0,7 km	7,3 km		33,7 km
Cost (Mill. NOK)	3752	405	3373	5000	12 529
Cost (Mill. EUR)	386	42	350	520	1298

5.5 Summary of Costs

Table 6: Summary of costs for alternatives 1, 2 and 3. Legge inn kostnad for oppgradering 10-15 milliarder NOK.

Alternative	Cost estimate Million NOK	Cost estimate Million EUR
1 – Narvik	5000	520
Upgrade Ofotbanen	10000	1040
2 – Skibotn	18 676	1937
Skibotn – Tromsø	31 845	3290
3 – Kirkenes	12 529	1298

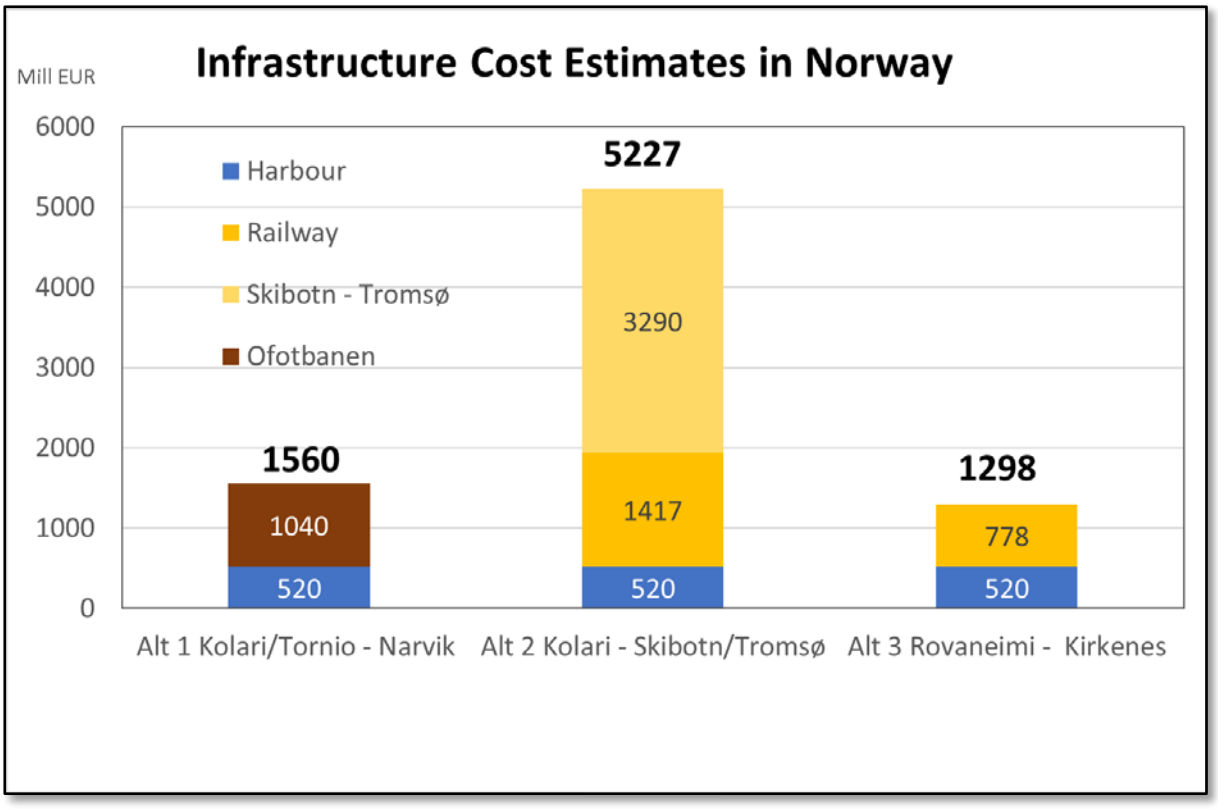

Figure 8: Cost estimates for the three alternatives.

6 Market analysis

6.1 Freight transport

6.1.1 Export of fish

Total export of fish from Norway was 2,6 million tons in 2017. Finland, Russia, Latvia, Estonia, Lithuania and Poland are most probably the countries which constitute the markets for rail transport through Finland in connection with fish export. Norwegian export of fish to these countries has been steadily growing for several years, apart from the Russian market, which became unavailable in 2014 due to import restrictions. In 2013, 300 thousand tons of fish were exported to Russia, whereas this market today amounts to only 2-3 thousand tons per year.

If the Russian market is reopened and exports to Russia are normalised, trade will probably rise, and the price of salmon will increase. If we calculate the potential for increased export of fish to Russia, given that the market is normalised, the total fish exports to the countries mentioned in Table 6 will be approximately 665 thousand tons per year.

Table 7: Export of fish from Norway, thousand tons per year. Source: Norway's Seafood Council

Destination country	2016	2017
Poland	210	196
Lithuania	85	93
Finland	42	50
Latvia	17	17
Estonia	8	7
Russia *	2	3
Sum	364	366

* Export of fish to Russia was approx. 300 thousand tons in 2013.

A previous survey (Institute of Transport Economics 2002) shows that truck is the clearly dominant means of transport for export of fresh fish from northern Norway. For other fish products, maritime transport is dominant. A total assessment was that 61 percent of all fish export from northern Norway are carried out by sea. A small part (1 percent) takes place by plane, and the rest on the truck and ferry.

6.1.2 Export of oil and gas

Norwegian foreign trade statistics from Statistics Norway (SSB) show that in 2016, 884 thousand tons of mineral oil or mineral oil products were exported to Finland. This increased to 1,5 million tons in 2017.

Of the other countries in the "Baltic corridor" only Poland imports of oil from Norway is of particular importance, i.e. 88 thousand tons in 2016 and 314 thousand tons in 2017. The oil is transported by ship to the markets.

The gas produced in the Barents Sea is being landed by pipeline to the facility at Melkøya at Hammerfest, from which it is transported to the various markets by ship.

Exports of gas to Finland were only 7 thousand tons in 2016 but increased to 35 thousand tons in 2017. Lithuania imported 955 thousand tons of gas from Norway in 2016 and 539 thousand tons in 2017.

6.1.3 Current transport flows across Finland's border from Norway

6.1.3.1 The Ofoten Line

Statistics from the Norwegian Railway Directorate show that in 2015, 17,7 million tons of ore were transported on the Ofoten Line for LKAB Malmtrafikk AS, with 14 train pairs per day. Ore transport for Northland Resources was closed in December 2014.

By 2015, train production consisted of combined train and truck load of 3,3 train pairs on average per day. These were the Arctic Rail Express (ARE with 1,4 train pairs, operated by CargoNet) and the North Rail Express (NRE with 1,6 train pairs, run by Green Cargo under the direction of DB Schenker), as well as cargo lanes (0,3 train pairs run by Green Cargo).

The Norwegian Railway Directorate informs that 30 % of total Norwegian aquaculture production in Northern Norway was transported over the Ofoten Line in 2013. However, no more detailed information is available on quantities and distribution of cargo types, either in the form of information from the train companies, from investigations or from the National Goods Model. This applies to both the current situation and the forecast for future development.

Passenger transport on the Ofoten Line amounts to approx. 70 thousand passengers per year, according to previous investigation by the National Rail Administration in 2011.

6.2 Market assessment for the year 2060

To assess the total export market to Finland and the countries in the "Baltic corridor", the National Freight Transport Model has been used. Basic forecasts for development in freight transport are used as the basis for the year 2050 and the growth is continued until 2060. The calculation results indicate that the export market for fish (weight transported) to Finland will increase by a factor of 3,5 in the period from 2016 to 2060.

For other export products from Norway to Finland, including mineral oil and gas (wet bulk), the baseline forecasts estimate an increase of factor 3,3 from 2016 to 2060. Export of dry bulk increases by factor 2,1. In terms of imports from Finland to Norway, the amount of goods increases by a factor of 2,5, that is, without any particular variation between the product groups.

The baseline forecasts provide a downward projection of freight transport flows to and from Norway, and do not catch trend changes or extraordinary market outlook related to the individual industries. It may therefore be necessary to account for this in an assessment of the market potential in the long term. This applies in particular to the market for export of fish and, if necessary, natural gas from northern Norway that may be relevant for rail transport by a new rail link between northern Norway and Finland with possible a connection to Europe.

The railway's role in Northern Norway was investigated in 2011 by the National Rail Administration, as part of the work on the Norwegian National Transport Plan 2014-2023. The report concluded that there is a potential for container transport on rail between Northern Norway and Eastern Norway, i.e. through Finland and Sweden. The analyses showed that these quantities are largely transferred from ship transport especially related to the markets in Salten and Troms. From Narvik, a lot of container transport is already available to Eastern Norway.

The freight transport model shows that approx. one third of all transport of intermodal product groups (fish, thermo products, piece goods and industrial goods) to and from Northern Norway are exports, while two thirds are domestic transport to and from the rest of the country.

A smaller proportion of transport to Northern Norway is imports. The base forecasts show a larger growth potential for the export market than for the domestic market, and in 2060 it is estimated that half of all transport of intermodal goods to and from Northern Norway will be in the form of imports and exports.

Table 8: Estimated redistribution of freight transport, compared to reference option 2060, based on projection of previous forecast (Jernbaneverket 2011). Intermodal product groups (fish, thermo products, packages and industrial goods). Thousands of tons per year.

	Railway (1000 ton)	From trucks	From container ship	From other ships	From combination of ship and rail
Kolari – Skibotn / Tromsø	234	25 %	10 %	38 %	27 %
Kolari – Svapparavaara – Narvik	98	27 %	5 %	2 %	66 %
Rovaniemi – Kirkenes	372	10 %	60 %	8 %	22 %

Table 9: Estimated potential distribution of intermodal commodity groups for freight transport by rail to / from Northern Norway for the construction of new rail link, according to previous forecasts (Jernbaneverket 2011).

Goods group	Percent
Fish	45%
Industrial goods	25%
Packages	25%
Refrigerated	5%
Sum	100%

The basis for the table below is the current distribution of fish exports to the countries of the Baltic corridor, as this is the largest product group, as well as the prerequisite for domestic transport between Northern Norway and Eastern Norway, according to the 2060 forecast of calculations with the national freight transport model.

Table 10: Estimated geographical distribution of potential for freight transport by rail to / from Northern Norway in the construction of a new rail link.

Geographic area	Percent
South Norway	43%
Finland	4 %
Russia	26 %
Baltic countries and Europe	28 %
Sum	100%

Some sources point out that the potential for export of fish is greater than that predicted by the calculations, which may also be applicable to rail transport in the corridors to and through Finland.

There is great uncertainty linked to total growth in the fishing industry when looking as far as 2060. How growth in the export market will be spread across different geographic markets implies further uncertainty.

Any exports of natural gas from Northern Norway by rail may also be relevant in the corridors to and through Finland, but this depends on developments in the oil and gas industry and claims of investments in gas plants that are also adapted for distribution on rail. Today, gas is exported from Norway on ships.

6.3 Passenger transport

Previous transport analyses for passenger transport in Northern Norway indicate that new rail connections could transfer some travel from other means of transportation within the country, but the potential is modest (Jernbaneverket 2011). There is a significant focus on summer and winter tourism in Finland, Sweden and Norway.

Today, many passengers are transported by bus to the north of Norway. A future railway could be part of a common concept of a tourism initiative between northern Finland, northern Sweden and northern Norway. A possible priority area may be combined travel by train between Norway and Finland, flights to and from Northern Norway, or boat along the coast of Norway.

7 Environment

7.1 Alternative 1: Tornio – Narvik

There are 2 variants for this alternative, as described in section 4.2.

Variant A is the use of the existing rail infrastructure from Tornio to Kiruna (connection to Malmbanan / Ofotbanen) via Haparanda and Gällivare.

Variant B is the use of the existing rail infrastructure from Tornio to Kiruna via Kolari. Since both variants use existing infrastructure or upgraded infrastructure, the environment topic has not been looked further into for the purpose of this feasibility study.

7.2 Alternative 2: Kolari – Skibotn – Tromsø

7.2.1 Summary of impacts

This railway line alternative conflicts with several areas of importance to nature, landscape, cultural heritage, outdoor recreation and reindeer husbandry. This is based on Norwegian official map data bases. On the nature, landscape and cultural heritage themes the data bases cover areas of formal protection or conservation and are based on existing registrations. In addition, it is likely that these and other areas are important for e.g. tourism, outdoor recreation, cultural heritage and farming, and this will need further mapping and consideration in future planning processes. Further planning will also have to consider corridor alterations for reducing impact, as well as possible mitigation measures.

7.2.2 Landscape and cultural heritage

Figure 9 illustrates valuable and vulnerable areas of landscape and cultural heritage on the Norwegian side in the corridor from Kolari via Skibotn to Tromsø.

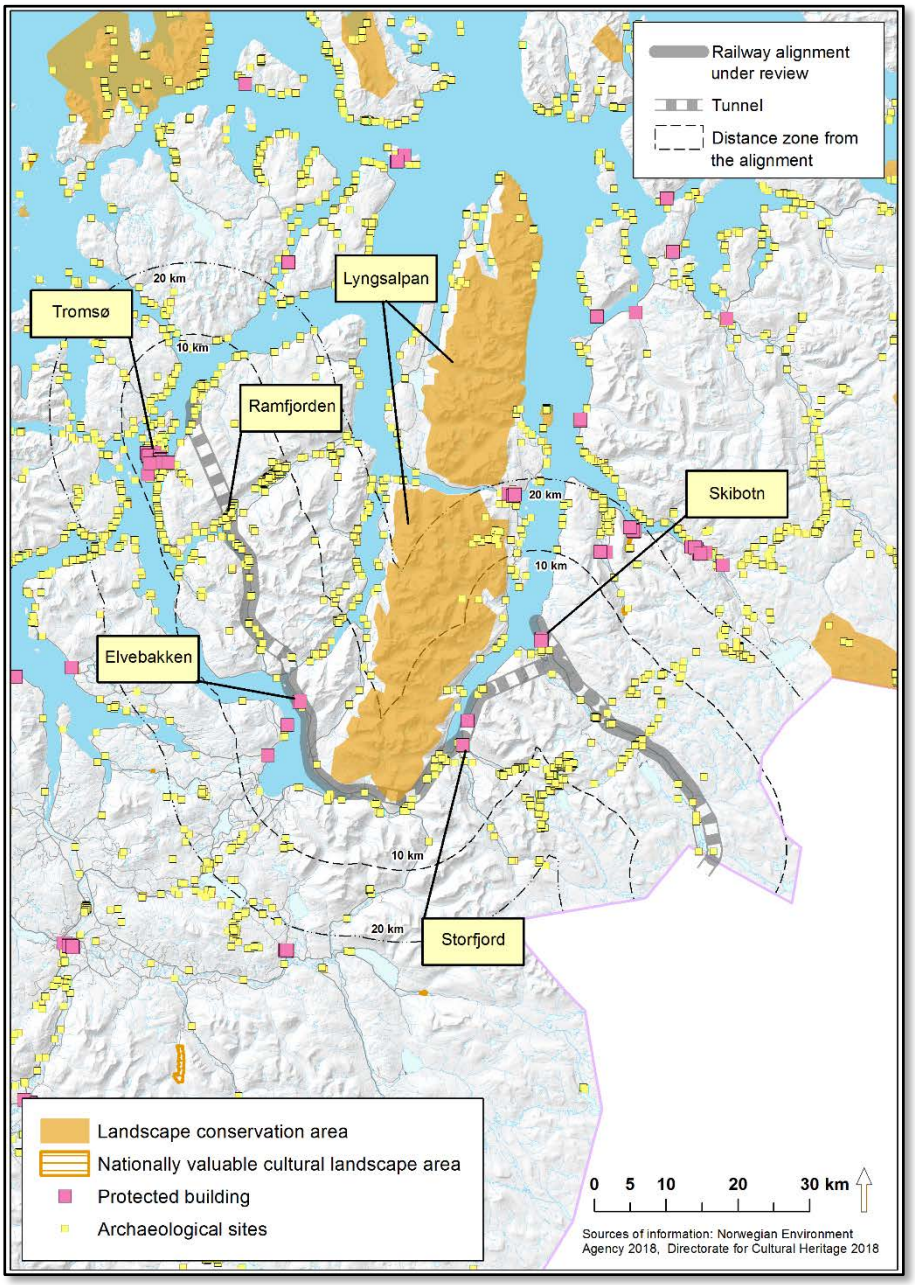

Figure 9: Map showing important areas for landscape and cultural heritage in the corridor Kolari-Skibotn-Tromsø

The corridor interferes with the southern outer area of the Lyngsalpan landscape conservation area. This area is significant when it comes to Sami, Kven and Norwegian cultural heritage; natural sciences such as glaciology and geology; bird life; reindeer husbandry and important areas for grazing; tourism and outdoor activities, especially mountain climbing.

There are several sites of importance to cultural heritage spread along the whole of the corridor. The map shows registered sites for archaeological findings and protected buildings, but it is likely that other areas and sites of significance can be found along the corridor.

There is a prevalent clustering of sites around populated areas, especially in the area around Storfjord and Ramfjorden.

Along the Skibotn valley there are several points for archaeological sites. World War II memorial sites are registered both in this valley and west of Skibotn but are largely avoided due to the railway tunnels in these areas.

7.2.3 Natural environment and protected areas

Figure 10 illustrates valuable and vulnerable areas of nature on the Norwegian side in the corridor from Kolari via Skibotn to Tromsø. The railway corridor comes close to nature areas protected through formal conservation laws.

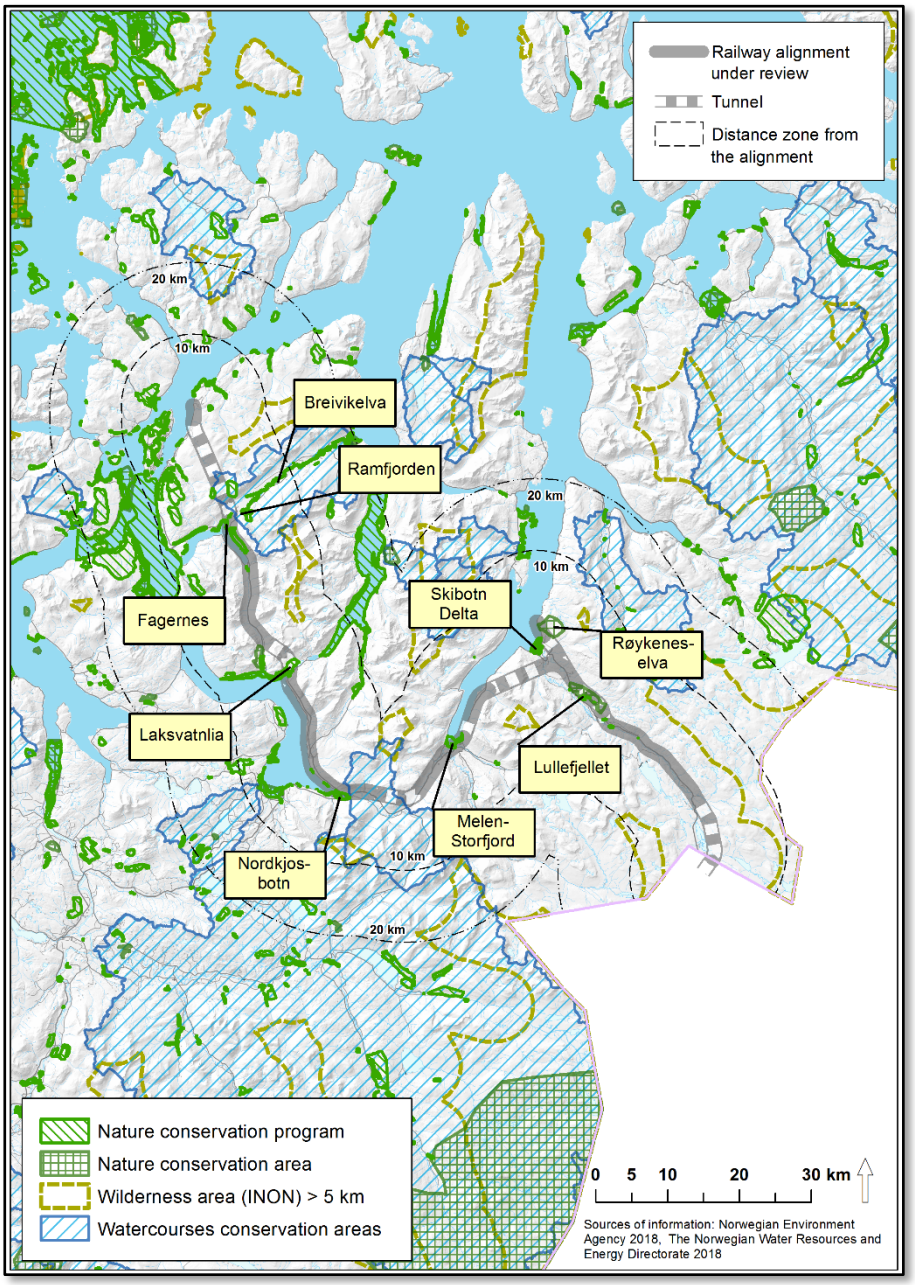

Figure 10: Map showing important areas of nature in the corridor Kolari-Skibotn-Tromsø.

Lullefjellet (the Lulle mountain) nature reservation southeast of Skibotn is one of the biggest lime pine forests in the Nordic countries, and is important due to its forest, plants and animal life.

Closer to Skibotn the corridor comes close to two reservation areas. The Skibotn delta has received its reservation status due to it being one of the most developed deltas in the county, as well as its variation in vegetation and bird life. The Røykeneselva nature reservation consists of a pine forest and has received its status due to the plants and animal life there.

Melen-Storfjord and Laksvatnlia are nature areas of high value. The first due to its marine soft-bottom qualities, and the second is a birch forest with a rich bird life and a diversity of lichen. Similarly, Fagernes is a birch forest of high value in the conservation program.

The map also shows watercourse conservation areas. They are mainly protected from power production but are also areas of consideration when it comes to larger impacts from new infrastructure. Protected waterways areas that may be affected by the railway corridor are the ones in Ramfjorden and south of Lyngsalpan.

Wilderness areas in Norway are divided into three categories based on their distance from the nearest human intervention: 1-3 km, 3-5 km and >5 km. It is important to be aware that the maps in this report only show the latter category. Wilderness areas will therefore be affected to a larger extent along the corridor than what the maps suggest. For example, the areas south of Ramfjorden and Fagernes consist of wilderness 1-3 km from nearest human intervention, as shown in figure 11.

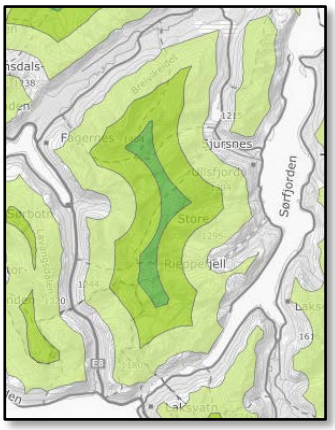

Figure 11: Example of the division of wilderness categories south of Ramfjorden and Fagernes.

7.2.4 Land use and population

The corridor from Kolari to Tromsø via Skibotn passes through three Norwegian municipalities: Storfjord, Balsfjord and Tromsø. In Storfjord, Skibotn is the largest populated area with approx. 600 inhabitants. In Balsfjord the corridor covers parts of mainly unpopulated areas. The municipal centre is Storsteinnes with approx. 1000 inhabitants. Tromsø municipality is the most populated municipality, with around 75.000 inhabitants, where Tromsø city is the municipal centre.

Most of the affected areas according to the municipalities' master plans are areas of nature, farming and outdoor recreation. Through the Skibotn valley the corridor aligns closely with the existing main road.

The areas affected are sparsely populated. Settlements can be found along the coast, clustered in delta areas, intersections between roads and in connection to farming. The corridor from Skibotn passes through the settlements in Oteren, along the Balsfjord river, in Norkjosbotn and along the Balsfjord before going into a tunnel by Kantornes.

7.2.5 Reindeer herding

A railway corridor represents other and more severe challenges for the reindeer husbandry than for example a road. This is due to the infrastructure and velocity associated with freight trains. Consequences can be accidents, but also the disturbance it may cause for the animals, leading to stress and thus complications for rutting, calving and grazing.

The corridor from Kolari to Skibotn cuts through a zone for special consideration concerning reindeer grazing in Storfjord municipality. It also divides a reindeer district (Helligskogen) along the existing road (see figure 12 for a map of the reindeer districts), and conflicts with several areas of significance to the reindeer husbandry. These conflicts can also be found on the route further to Tromsø. The areas of importance include land for grazing, movement and herding facilities.

Figure 12: Map showing the administrative reindeer herding districts in the area of the corridor from Kolari til Tromsø.

7.3 Alternative 3: Rovaniemi - Kirkenes

7.3.1 Summary of impacts

As in the corridor to Skibotn and Tromsø, the corridor to Kirkenes conflicts with valuable and vulnerable areas. This includes areas of nature reservation and protection, cultural heritage, military purposes and reindeer husbandry. This is based on Norwegian official map data bases. In addition, it is likely that other areas are important for e.g. tourism, outdoor recreation, cultural heritage and farming, and this will need further mapping and consideration in future planning processes. Further planning will also have to consider corridor alterations for reducing impact, as well as possible mitigation measures.

7.3.2 Landscape and cultural heritage

Figure 13 illustrates valuable and vulnerable areas of landscape and cultural heritage on the Norwegian side in the corridor from Rovaniemi to Kirkenes.

The corridor comes close to cultural heritage sites and areas of cultural significance. For example, the route is in proximity to important sites near the Munk river. In addition, sites of archaeological findings and cultural heritage are clustered around Høybukta and Kirkenes. As mentioned there are likely to be other areas of interest and importance when it comes to cultural heritage in the areas affected by the railway. Neiden and the surrounding area is especially important for the Skolt Sami population and heritage.

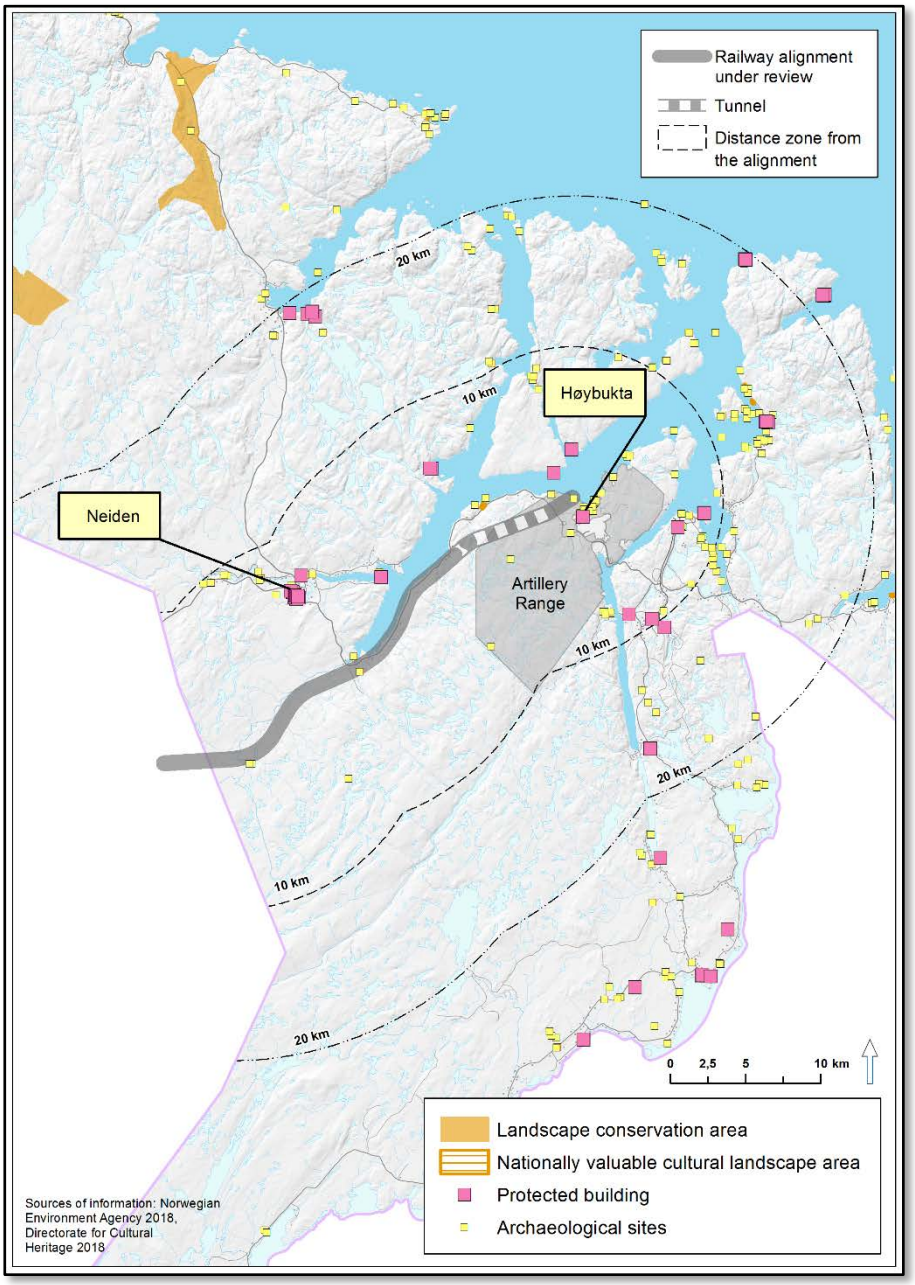

Figure 13: Map showing important areas of cultural heritage in the corridor Rovaniemi-Kirkenes.

7.3.3 Natural environment and protected areas

Figure 14 illustrates valuable and vulnerable areas of nature on the Norwegian side in the corridor from Rovaniemi to Kirkenes.

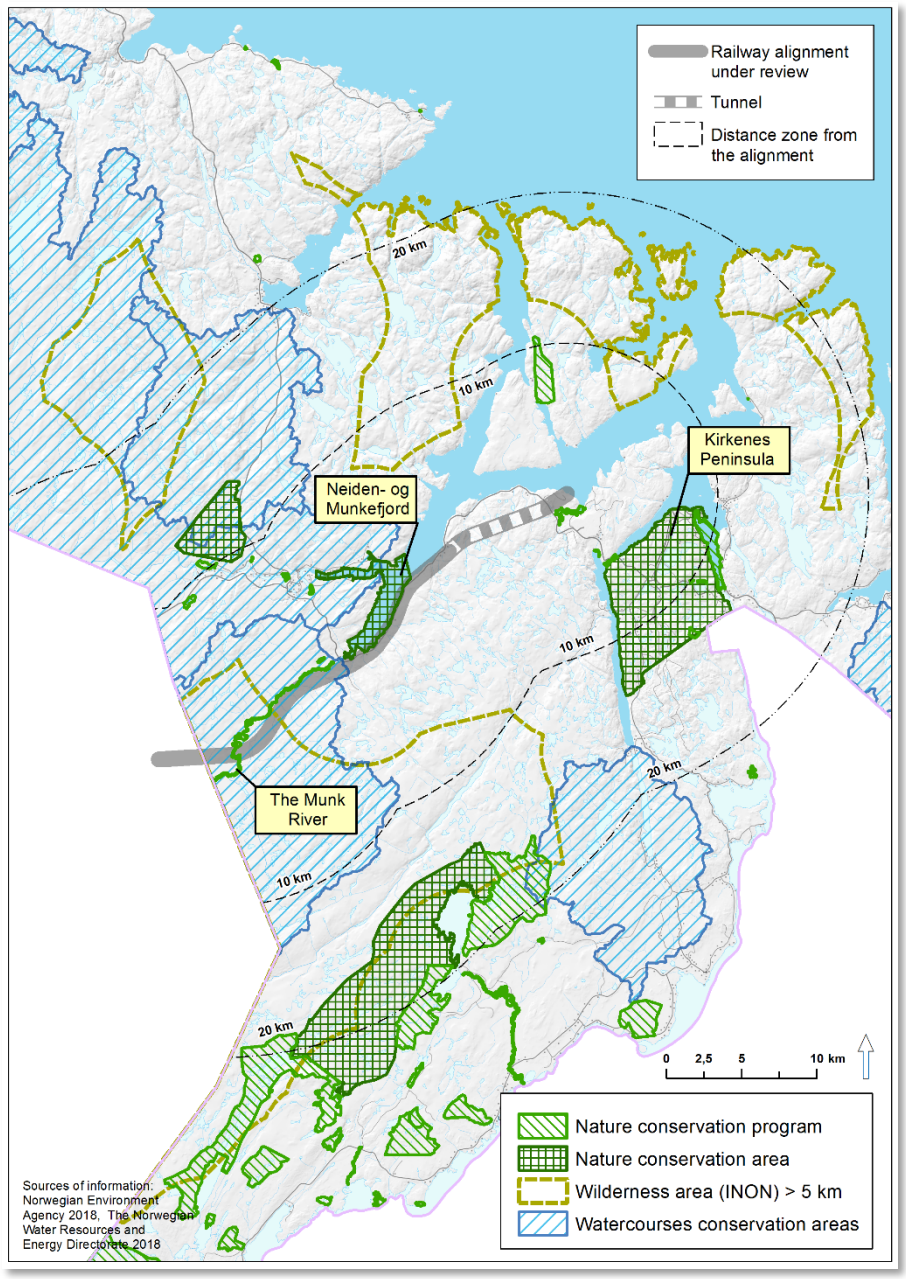

Figure 14: Map showing important areas of nature in the corridor Rovaniemi-Kirkenes.

The corridor comes close to nature areas protected through conservation laws. The Neiden and Munkefjord nature reservation consists of mostly low tide and shallow water, with a limited amount of land areas. Kirkeneshalvøya (covering the Kirkenes peninsula) has a status as an animal life reservation area for mammals and birds.

The Munk river is defined as a significant nature area of high value in the nature conservation program. Among other reasons, this is due to its intact condition, the findings of two red listed species, the probability of more red listed species, and its intact meanderings that lead to a variety of nature types. Another interest of this river is linked to the fishing of sea trout and salmon.

Like for the Kolari – Tromsø corridor, the corridor to Kirkenes interferes with watercourse conservation areas, where the Munk river is a part of this.

As mentioned in section 7.2.3, the maps only show the wilderness area category of >5 km distance from nearest human intervention.

7.3.4 Land use and population

The corridor from Rovaniemi goes through the municipality of Sør-Varanger. Kirkenes is the administrative centre with a population of approx. 3,500 people. Along the route the populated areas, although very sparse, are found along the coast of Munkefjord and in Høybukta.

Sør-Varanger municipality is, in cooperation with the Norwegian Coastal Administration and the Norwegian Public Road Administration, planning a new harbour in Kirkenes. They are currently evaluating different alternatives. The harbour will be served by road infrastructure. If a railway to Kirkenes will be built, this harbour will be an obvious choice for termination.

Another area of importance is the Norwegian Armed Forces' artillery range area that covers a large part south of Høybukta and the Kirkenes airport.

7.3.5 Reindeer herding

The corridor cuts through a reindeer district (Pasvik, see figure 15), and conflicts with areas of significance to the reindeer husbandry. These include land for grazing, movement and facilities, as in the corridor from Kolari to Tromsø.

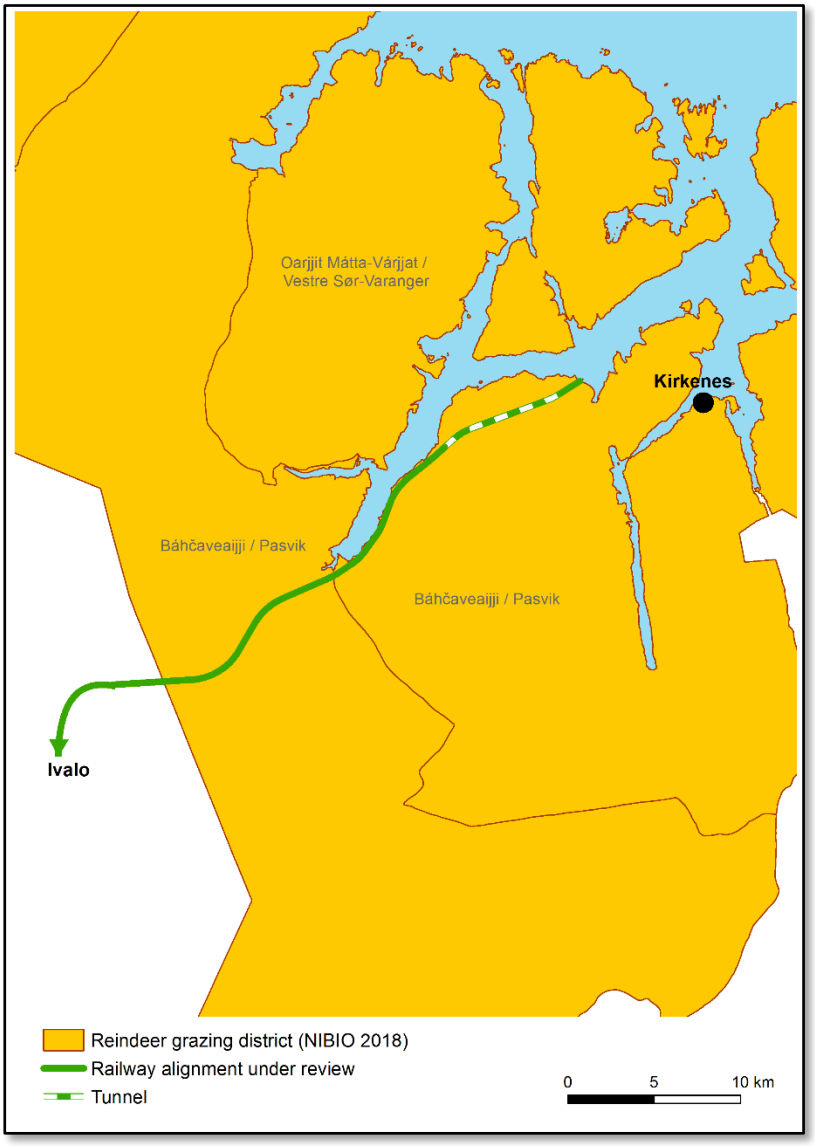

Figure 15: Map showing the administrative reindeer herding districts in the area of the corridor from Rovaniemi to Kirkenes.

Version	Date	Description	Prepared by	Checked by	Approved by
1,0	2018-02-23	Final report - Arctic Railway	TJP	KRIWEN	HPD