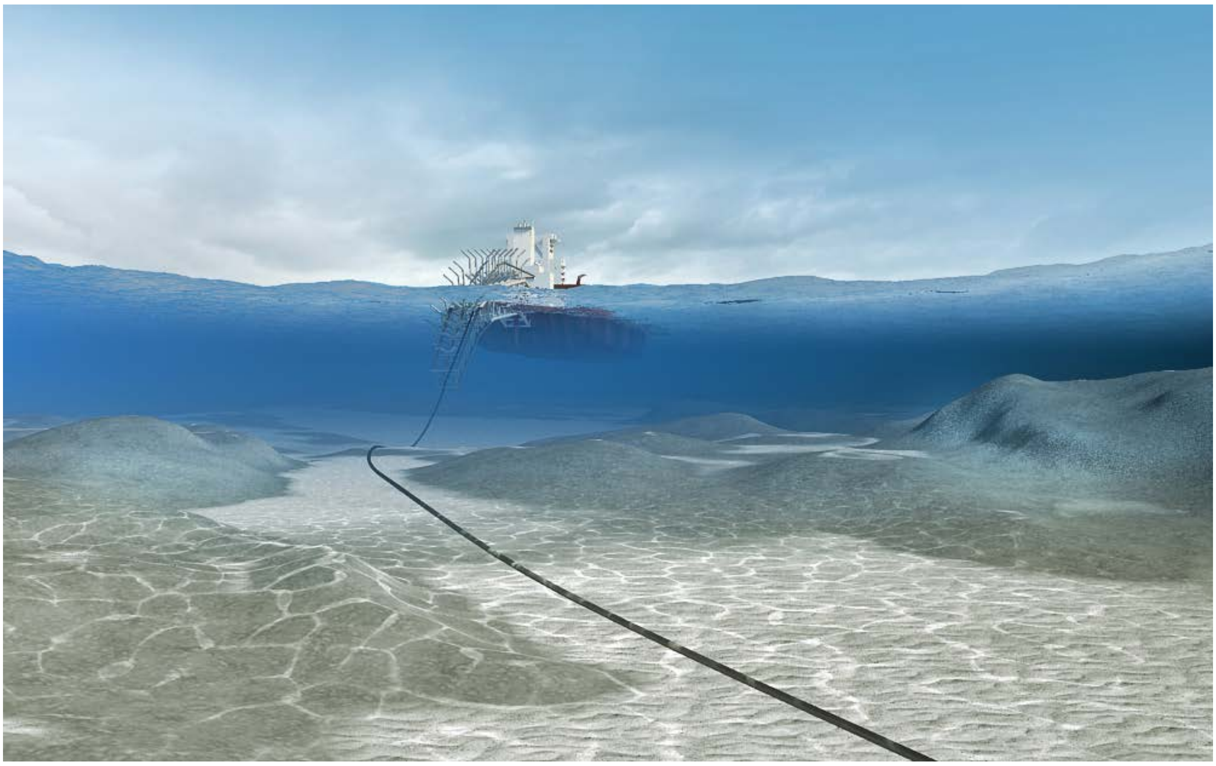

BALTICCONNECTOR

Natural gas pipeline between Finland and Estonia

2015

Environmental impact assessment report

Estonia

Gasum
EG Võrguteenus maagaas
PÖYRY

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The EIA report and related material are available online at
http://www.balticconnector.fi and at http://www.egvorguteenus.ee/kasulikku/balticconnector/

The project's EIA report for Finland is available in English at http://www.balticconnector.fi

FOREWORD

Gasum Corporation (hereinafter Gasum) and the Estonian company AS EG Võrguteenus are jointly planning the Balticconnector natural gas pipeline to interconnect the Finnish and Estonian natural gas distribution networks.

The environmental impact assessment (EIA) procedure for the project has been conducted in both countries in compliance with national legislation. The procedure has involved the production of separate environmental impact assessment reports (EIA reports) in Estonia and Finland. This EIA report was compiled by Pöyry Finland Oy and the EIA program by Ramboll. Information presented in the EIA program has been utilized as appropriate extent in the preparation of the EIA report.

This report is the EIA report for Estonia presenting and comparing the environmental impacts in Estonia of the alternatives presented in the Environmental Impact Assessment Program. A brief description of the project's key impacts in Finland is presented as an appedix (appendix 5). The full Finnish EIA report is available on the Gasum website in Finnish and English *(http://www.balticconnector.fi)*. Due to the international dimension of the project, the EIA procedure has also been carried out in compliance with the UNECE Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and the bilateral Agreement between Estonia and Finland on Environmental Impact Assessment in a Transboundary Context.

The aim of the environmental impact assessment has been to give permitting authority information about possibilities for the prevention and mitigation of negative impacts caused by alternatives of proposed activity in Estonia and Finland. The EIA procedure covers the natural gas pipeline route from Ingå, Finland, to Paldiski, Estonia. The examination of the pipeline route in Estonia and Finland covers the routing alternatives proposed.

The Balticconnector natural gas pipeline aims to considerably improve regional access to and the supply security of natural gas and promote the reliability of natural gas distribution in different circumstances in Finland and the Baltic states. The Balticconnector natural gas pipeline project is categorized as a priority project in the guidelines for trans-European energy networks (TEN-E) and has been granted financial assistance by the EU. The Balticconnector is also included in the EU's list of Projects for Common Interest (PCI) published in autumn 2013, and the related applications for EU support were submitted in August 18, 2014.

The Balticconnector natural gas pipeline will be connected to the existing gas network in Finland and Estonia and to a regional LNG terminal. The LNG terminal development project is also currently underway. The Balticconnector will enable a bidirectional flow of natural gas between Finland and Estonia.

The Balticconnector natural gas pipeline project was one of the mini pilot projects of the IMPERIA project co-funded by the EU Imperia 2015. The multi-criteria decision analysis (MCDA) practices and tools developed in the IMPERIA project were employed as appropriate in the assessments of environmental impacts and their significance in Finland and Estonia.

Gasum Corporation, Espoo, April 2015

TABLE OF CONTENTS

CONTACT INFORMATION 2

FOREWORD 3

APPENDICES AND SEPARATE REPORTS 7

1 SUMMARY 8

GLOSSARY 16

2 DESCRIPTION OF THE PROJECT 19
- 2.1 Project developers 19
- 2.2 Purpose of the project 19
- 2.3 Project background 19
- 2.4 Route alternatives 20
  - 2.4.1 Previously studied route alternatives 20
  - 2.4.2 Assessed alternatives in the EIA procedure 22

3 TECHNICAL DESCRIPTION OF THE PROJECT 29
- 3.1 Project design stages 29
- 3.2 Properties of natural gas 29
- 3.3 Technical characteristics of the natural gas pipeline 30
  - 3.3.1 Pipeline coating 30
  - 3.3.2 Protection against corrosion 31
- 3.4 Construction 32
  - 3.4.1 Seabed intervention 32
  - 3.4.2 Infrastructure crossings 36
  - 3.4.3 Munition removal 37
  - 3.4.4 Offshore pipe-laying 37
  - 3.4.5 Pipeline tie-in 40
  - 3.4.6 Landfalls 40
  - 3.4.7 Construction of onshore pipeline sections and related functions 42
  - 3.4.8 Project logistics 44
- 3.5 Pre-commissioning and commissioning 44
  - 3.5.1 Flooding and hydrostatic testing 44
  - 3.5.2 Gauging and cleaning 45
  - 3.5.3 De-watering and drying 45
  - 3.5.4 Nitrogen purging and gas filling 45
- 3.6 In-use operations and control 46
- 3.7 Schedule of the project 46
- 3.8 Relationship of the project with other relevant strategies and planning documents 46
  - 3.8.1 Conformity with European Union and other international energy and environmental objectives 46
  - 3.8.2 Conformity of the project with objectives of Estonian environmental protection 47
  - 3.8.3 Relationship of the assessed project with strategic planning documents 48

4 THE EIA PROCEDURE FOR THE PROJECT 51
- 4.1 The international EIA procedure 51
  - 4.1.1 The Espoo Convention 51
  - 4.1.2 Bilateral agreement between Estonia and Finland 51
- 4.2 The EIA procedure in Estonia 52
  - 4.2.1 Applying the EIA procedure in Estonia 52
  - 4.2.2 Initiation of the EIA procedure 53
  - 4.2.3 EIA program phase 53
  - 4.2.4 EIA report phase 54
  - 4.2.5 Permitting phase 54

4.2.6 Projects of Common Interest (PCI) 55
4.3 Schedule of the EIA procedure 55
4.4 Parties to the EIA procedure 55
4.5 Participation in the EIA procedure 57

5 CURRENT STATE OF THE ENVIRONMENT 58
5.1 Current state of the Gulf of Finland and of the sea area in Estonia 58
5.1.1 Bathymetry 58
5.1.2 Seabed morphology and sediments 59
5.1.3 Glacial isostasy and post-glacial rebound 63
5.1.4 Munitions and waste dumped in the sea 63
5.1.5 Currents 64
5.1.6 Ice conditions 69
5.1.7 Hydrology and water quality 70
5.1.8 Benthic flora and fauna 76
5.1.9 Plankton 79
5.1.10 Fish and fisheries 82
5.1.11 Bird fauna 92
5.1.12 Marine mammals 104
5.1.13 Noise 107
5.1.14 Air quality 108
5.1.15 Vessel traffic 109
5.1.16 Military areas 111
5.1.17 Underwater monuments of cultural heritage 112
5.1.18 Nature reserves 114
5.2 Current state in Pakri area 114
5.2.1 Coast and shore processes of Lahepere Bay 114
5.2.2 Geology 117
5.2.3 Hydrogeology 118
5.2.4 Surface water 118
5.2.5 Air quality 120
5.2.6 Noise 121
5.2.7 Vibrations 121
5.2.8 Natural environment 121
5.2.9 Socio-economic environment 141
5.2.10 Monitoring stations and areas 154

6 STARTING POINTS OF THE ENVIRONMENTAL IMPACT ASSESSMENT AND THE ENVIRONMENTAL IMPACTS ASSESSED 156
6.1 Scoping of the assessment 156
6.2 Environmental impacts assessed 157
6.3 Studies and assessments carried out for the project 157
6.4 Assessment methods 157
6.4.1 Assessment of the significance of the impacts 157
6.4.2 Components of impact significance 158
6.4.3 Assessing the significance of an impact 158
6.5 Offshore natural gas pipeline 159
6.5.1 Impact on the seabed 159
6.5.2 Impact on hydrology and water quality 160
6.5.3 Impact on marine benthos 177
6.5.4 Impact on plankton 180
6.5.5 Impact on fish fauna 182
6.5.6 Impact on marine birds 190
6.5.7 Impact on marine mammals 193
6.5.8 Impact on protected natural objects 195
6.5.9 Impact on the coast 195
6.5.10 Noise 196
6.5.11 Vibrations 201

6.5.12 Air emissions . . . 202
6.5.13 Waste and waste handling . . . 204
6.5.14 Impact on mineral resources . . . 205
6.5.15 Impact on socio-economic environment . . . 206
6.6 Onshore natural gas pipeline . . . 212
6.6.1 Impact on soil . . . 212
6.6.2 Impact on surface- and groundwater . . . 213
6.6.3 Impact on air quality . . . 214
6.6.4 Noise . . . 215
6.6.5 Impact on the natural environment . . . 218
6.6.6 Impact on the socio-economic environment . . . 226
6.6.7 Impact on the technical infrastructure . . . 232
6.7 Natura assessment . . . 232
6.7.1 Information on planned activities . . . 232
6.7.2 Description of potentially impacted Natura 2000 areas . . . 235
6.7.3 Assessment of impact . . . 242
6.7.4 Cumulative impact . . . 255
6.7.5 Mitigation measures . . . 257
6.7.6 Omissions and possible inaccuracies . . . 257
6.7.7 Conclusions . . . 257
6.8 Decommissioning . . . 258
6.8.1 Assessment methods and assessment uncertainties . . . 258
6.8.2 Environmental impacts assessed . . . 258
6.9 Exceptional and accident situations . . . 259
6.9.1 Impact of construction activities . . . 259
6.9.2 Impacts during operation . . . 261
6.9.3 Prevention and mitigation of adverse impacts . . . 265
6.9.4 Summary of the significance of impacts and comparison of alternatives . . . 266
6.10 Zero alternative . . . 266
6.11 Cumulative impacts . . . 266
6.11.1 Gulf of Finland marine area . . . 266
6.11.2 Paldiski area . . . 269
6.12 Transboundary impacts across the borders of Estonia . . . 272
6.13 Use of natural resources and the compliance of construction of the natural gas pipeline with the principles of sustainable development . . . 273

7 COMPARISON BETWEEN ALTERNATIVES . . . 275
7.1 Principles applied in the comparison between alternatives . . . 275
7.2 Comparison between alternatives . . . 275
7.3 The most significant environmental impacts . . . 279
7.4 Impacts on marine strategy objectives . . . 282
7.5 Feasibility of alternatives and summary of comparison . . . 285

8 UNCERTAINTIES RELATED TO THE ASSESSMENT WORK . . . 288

9 MITIGATION MEASURES . . . 290

10 ENVIRONMENTAL IMPACT MONITORING PROGRAM . . . 292
10.1 Water quality and marine environment . . . 292
10.2 Fish, birds and marine mammals . . . 293
10.3 Noise . . . 293
10.4 Shipping, people and society . . . 293
10.5 Nature . . . 294

11 REFERENCES . . . 295

APPENDICES AND SEPARATE REPORTS . . . 303

APPENDICES AND SEPARATE REPORTS

APPENDIX 1	EIA program and documentation
APPENDIX 2	Approval of the EIA program by the Ministry of the Environment
APPENDIX 3	EIA report procedure documentation
APPENDIX 4	IMPERIA tool classification criteria
APPENDIX 5	Summary of the EIA report for Finland

The separate reports produced during the project's EIA procedure are available on the Gasum website at http://www.balticconnector.fi.

1 SUMMARY

In early 2014 an environmental impact assessment (EIA) procedure was launched concerning the construction of a natural gas pipeline between Finland and Estonia, developed by Finnish Gasum Corporation and the Estonian AS EG Võrguteenus. The Balticconnector natural gas pipeline project aims to considerably improve regional access to and supply security of natural gas and promote the reliability of natural gas distribution in different circumstances in Finland and the Baltic states.

The purpose of the EIA procedure was to assess the project's environmental impacts and increase the project's openness and stakeholder interaction. This EIA report covers the preliminary route of the offshore Balticconnector natural gas pipeline from Ingå, Finland, to Paldiski, Estonia, and the related routing alternatives in Estonia. The routing alternatives for the Ingå area are covered by the EIA report for Finland, which is available in Finnish, Swedish and English on the Gasum website (*http://www.balticconnector.fi*). The most significant environmental impacts of the routing alternatives in Finland are also described in Appendix 5 of this EIA report.

The contents of this EIA report by chapter are shown in the table below.

EIA report chapter	Chapter contents in brief
1. Summary	The chapter provides a brief description and summary of the Balticconnector EIA procedure and its results.
2. Project	The purpose of the chapter is to present the project. A brief description of the parties responsible for the project, their business activities and position from the project perspective as well as backgrounds and purpose of the project is provided. The chapter also presents the project schedule and the relationship of the project with other projects. The chapter covers the previously studied routing alternatives, the selection of the current route, and the alternatives assessed in the EIA procedure.
3. Technical description	The chapter further describes the phases, procedures and technical data relating to project design, construction and operation.
4. Environmental impact assessment procedure	The chapter describes the EIA procedures carried out for Estonia as well as Finland taking the requirements of international consultations and the bilateral agreement between the countries into consideration. The chapter covers the content and schedule of, parties to as well as communications and participation relating to the EIA procedure. The licenses, permits, plans and decisions required for the project are also described in the chapter.
5. Current state of the environment	The chapter describes the current state of the environment as regards the Gulf of Finland and the Pakri area of Estonia.
6. Starting points of the environmental impact assessment and the environmental impacts assessed	The chapter describes the starting points of the EIA and covers the scoping, significance and extent of the environmental impacts in general. In the assessment work, the multi-criteria decision analysis (MCDA) practices and tools developed in the EU LIFE+ IMPERIA project were employed as appropriate in the assessment of the significance of the environmental impacts. The chapter presents the results if the impact assessment by environmental impact, including cumulative impacts with other known projects, impacts of project decommissioning and transboundary effects. A summary of the significance of the impacts and comparison between alternatives is also provided in conjunction with assessment results.
7. Comparison between alternatives	The chapter describes the principles, phases and results of the comparison carried out between the alternatives. The chapter aims to also provide the reader with a clear idea of the feasibility of the alternatives and of how the comparison between the alternatives was carried out and what its results are based on.
8. Uncertainties relating to the impact assessment	The chapter presents the uncertainties relating to the impact assessments carried out.
9. Prevention and mitigation of adverse impacts	The chapter describes the means and ways that can be employed by the parties responsible for the project in subsequent project phases to prevent or mitigate any adverse impacts caused by the project and assessed in the EIA report.
10. Environmental impact monitoring program	The chapter describes the plans made by the parties responsible for the project for environmental impact monitoring during and after the project.

Application and stages of the EIA procedure

The offshore natural gas pipeline will enable the transmission of natural gas between Finland and Estonia. Due to the international dimension of the Balticconnector project, two main international procedures are applied to the project: the UNECE Convention on Environmental Impact Assessment in Transboundary Context (Espoo Convention) and the bilateral Agreement between Finland and Estonia on Environmental Impact Assessment in a Transboundary Context.

The need for the assessment of the project's environmental impacts for Estonia is based on the Estonian Environmental Impact Assessment and Environmental Management System Act. The Balticconnector project is included in the list of projects provided by Chapter 6 of the Estonian EIA decree under which it is classified as a project with essential environmental impacts. According to this legislation, (*Environmental Impact Assessment and Environmental Management System Act § 6 section 1 clause 17*) "marine dredging, starting from the soil volume of 10,000 cubic metres, sinking of solid substances into the seabed, starting from the soil volume of 10,000 cubic metres", are listed as activities with significant environmental impact and therefore the EIA process is compulsory (*RT III, 17.12.2013, 6 Hoonestusloa menetlemise algatamine*). On May 14, 2013, Gasum Corporation submitted an application to the Estonian Ministry of Economic Affairs and Communications (MEAC) for a superficies license to burden a public water body and to install a natural gas pipeline on the seabed. Based on Estonian Government order (12.12.2013 No 555) on the initiation of superficies license proceedings (RT III, 17.12.2013), it was decided to initiate the EIA procedure.

The Estonian EIA procedure comprises two stages. Firstly, an environmental impact assessment program is prepared. This is a plan specifying the impacts to be assessed and how they will be assessed. The Project Developers submitted the EIA program to the permitting authority, which on February 2, 2014 gave notification of the public display of the EIA program. The EIA program was displayed for statements and opinions from February 10 to April 7, 2014. Public consultations in respect of the program took place on April 15, 2014 in Paldiski and on April 16, 2014 in Tallinn. The opinions and statements provided were included in the program, and on May 23, 2014 the EIA program of the Balticconnector project was submitted for the approval of the Ministry of the Environment, which issued its statement for the supplementation of the program on June 20, 2014. The supplemented EIA program was submitted on June 30, 2014 to the Ministry of the Environment, which approved of it by letter No 11-2/14/1093-9 dated July 15, 2014.

The report proper concerning the project's environmental impacts – the EIA report – was produced in the second stage of the EIA procedure. The EIA report was prepared on the basis of the EIA program and the opinions and statements provided concerning it. Investigations for this EIA report commenced in spring 2014, and the report was submitted to the coordinating authority in April 2015. The work was guided by the statements and opinions received during the program stage as well as comments provided at public consultations.

Citizens and various stakeholders may express their opinion about the EIA report within the period of time specified by the permitting authority. The EIA procedure will be completed once the EIA report is approved by the supervising authority. The EIA report as well as the stakeholder interaction carried out and the material acquired during the EIA procedure will provide important support to more specific planning and design concerning the project, as well essential information for the permitting authorities.

Project description and alternatives assessed

In addition to the entire pipeline route, the following alternatives were examined in the environmental impact assessments conducted (Figure 1-1):

In Estonia

- **Alternative EST 1 (ALT EST 1):** Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, with the point of landfall in Kersalu, Estonia.
- **Alternative EST 2 (ALT EST 2):** Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, with the point of landfall in Pakrineeme, Estonia. ALT EST 2 is referred to as "Pakrineeme" in this EIA report (as in the EIA Program: *Ramboll 2014a* and LNG terminal documents: *Sweco Project AS 2012 and 2014*).

In Finland

- **Alternative FIN 1 (ALT FIN 1):** Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, route north of Stora Fagerö.
- **Alternative FIN 2 (ALT FIN 2):** Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, route south of Stora Fagerö.

In addition, two alternative points of landfall in Finland and the respective natural gas pipeline routings in Ingå were examined:

- **Landfall 1 (LF1)**: Landfall of the Balticconnector natural gas pipeline north of the Fjusö Peninsula in the Bastubackaviken Bay area.
- **Landfall 2 (LF2)**: Landfall of the Balticconnector natural gas pipeline on the Fjusö Peninsula.

A situation where the Balticconnector natural gas pipeline will not be constructed was assessed as the zero alternative.

Route alternatives in Estonia

Two route alternatives were studied in Lahepere Bay and on the Pakri Peninsula. Both alternatives run through the shallow Lahepere Bay and the landfalls are located on the Pakri Peninsula.

The landfall point in ALT EST 1 is in Kersalu. **At the Kersalu landfall,** the main scarp of the North Estonian Klint, rises up to a height of 9 m from a narrow high-water shore. According to the comprehensive plan of the City of Paldiski, Kersalu is a promising residential area by Lahepere Bay. The ALT EST 1 alternative also features an onshore gas pipeline of around 1.3 km in length running from the landfall to the planned compressor station.

The landfall point in ALT EST 2 is at Pakrineeme in the Pakri Landscape Reserve Area, away from human settlements – no existing or planned residential areas are located in the proximity of the landfall. The region is developing into an area with industrial land use, containing the Paldiski wind farm, and a detailed plan has been approved for the construction of the Paldiski LNG terminal's onshore facilities. **At the Pakrineeme landfall**, the scarp of the North Estonian Klint, rises sharply up to a height of 23 m approximately 17 m from the shore.

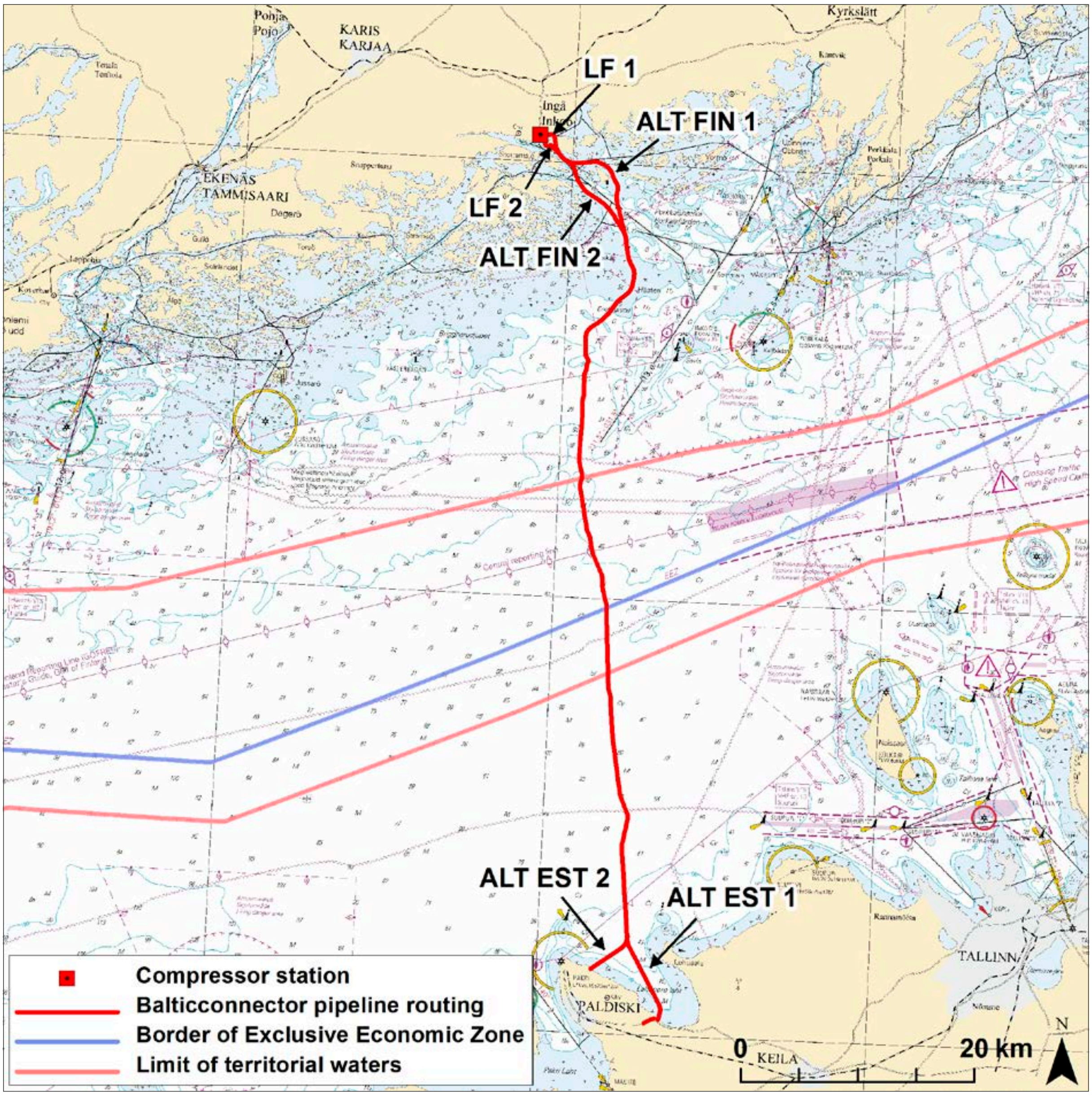


Figure 1–1. The routing alternatives of the Balticconnector natural gas pipeline.

The most significant environmental impacts

The most significant environmental impacts of the project will arise during the construction of the natural gas pipeline. Adverse impacts during pipeline operation will be of lower significance. Impacts identified as the most significant impacts during construction are impacts on seabed, water quality, the marine environment, flora and fauna as well as nature reserves.

According to preliminary calculations and plans, a significant amount of seabed intervention measures (dredging, ploughing or jetting, blasting and subsea rock installation) will be required for pipeline protection and freespan rectification. The actual need for seabed intervention will be specified further once progress is made in technical project design, with the need for intervention for each pipeline section likely to be reduced below the level presented in this EIA report. The environmental impact assessments conducted are based on conservative assessments concerning project measures and efforts have been made to conduct them on the basis of the worst-case scenarios.

Impacts during construction

Offshore areas

Dispersion of re-suspended particles in the open part of the Gulf of Finland (outside Lahepere Bay) in the case of weak winds is mostly characterized by transportation along the gulf (in the deep layer along the deeper part of the gulf), and along the slope towards the northeast (east). This flow can be intensified or reversed due to winds. The SW-NE-oriented cloud of re-suspended particles is characteristic 4–5 days after the beginning of the work period. In the case of strong winds, the sediment would disperse further, but the diffusion of floating material is significantly higher, and therefore the decrease in water transparency near the work site would be highly limited in time (turbidity decreases faster).

Impacts on water bodies were also found to be temporary, local and low in the environmental monitoring carried out during the construction of the Nord Stream gas pipeline project. In offshore areas the duration of noise and other disturbances will also be shorter than in near-shore areas as construction work will progress faster further off the shore.

Where permitted by the ice situation, some birds, seals and occasionally also harbor porpoises are found in the open sea areas of the Gulf of Finland. No particularly important feeding areas attracting large numbers of individuals are known in the area covered by the natural gas pipeline project. Among birds, Anseriformes in particular prefer feeding in shallow areas very rarely found in open sea areas. The impacts of offshore turbidity on bird fauna are likely to be low as the impacts on fish, bivalves and other small fauna that they feed on are estimated to be very local and short-term. Deep-bottom zoobenthos will be destroyed almost all the way underneath the pipeline, but on the whole the natural gas pipeline is not estimated to pose a major risk to offshore soft-bottom benthic communities which, due to the poor oxygen situation, are quite non-diverse and have good recovery potential.

Fish populations are impacted particularly by underwater explosions, which result in behavioral changes over several kilometers and risk of injury up to hundreds of meters from the blasting site. Benthic fish are also affected by changes in the benthos, which may have either negative or positive impacts depending on the species of fish. No significant fish spawning areas can be found in the offshore zone of the project area. The impact on fisheries is reduced by the fact that the impact focus will be on mature fish.

Adverse effects on fishing in the offshore areas of the Gulf of Finland will mainly be caused by the prevention of trawling in the project area during construction. Fishing vessels operating in the area will be disturbed by increased vessel traffic, seabed intervention work, pipelaying as well as pipeline protection measures. In the Gulf of Finland however, where fairway crossings take place in the open sea, the impacts on other vessel traffic will be low as there will be plenty of space around the protection zone of the pipelaying vessel for diversionary routes, resulting in only short detours.

The most significant risks relating to the construction of the natural gas pipeline comprise the collision of installation vessels participating in pipelaying with other vessels as well as any munitions and barrels containing hazardous substances found in the seabed in the construction area. The prevention of safety incidents is the primary goal set for planning. Planning will take place in compliance with legislation as well as safety and occupational health and safety rules. Efforts will be made to prevent vessel collisions and groundings through traffic control. The disposal of munitions and barrels will be negotiated with the relevant national authorities.

Coastal areas

Both alternatives (ALT EST 1 and ALT EST 2) would run across shallow Lahepere Bay and the landfalls are on Pakri Peninsula.

Damage to littoral benthic fauna can be expected to be greater when compared to the open sea. Restoration of the benthic fauna ecosystem is possible, but recovery will depend greatly on the surrounding environmental conditions and will take 1–5 years. Since the negative impact will be temporary and limited in scope, it can be classified as moderate.

The construction activity of Balticconnector has moderate impact on the local fish fauna and mostly affects certain individuals in the region and has no significant impact on the species as a whole. The construction will cause noise, increase in the concentration of sediments and substances in the water column, changes and disturbances on the seabed and changes in the food basis of fish. However, on population level the impact is reversible, and concludes with the conclusion of construction work. The impact on fishing deriving from fish fauna during the construction period is assessed as moderate and reversible.

The impact of noise and visual disturbance on birds will be direct, negative and intensive, but due to its short duration it is evaluated to be moderate. Highest risks are expected in the Pakri Natura 2000 site, where sound pressure levels will be highest during the construction phase (pipelaying and trenching). In the Natura 2000 MPAs marine mammals acoustic thresholds should not be exceeded during pipeline construction.

Both alternative routes of the Balticconnector natural gas pipeline run through the Pakri Habitats Directive and Birds Directive sites. Significant impacts without implementation of mitigation measures cannot be excluded to concern habitat type 1110 in both alternatives. This is not a priority habitat, and mitigation measures will reduce the impact to insignificant.

In ALT EST 2, significant impact cannot be excluded for priority habitat 9180*, because it cannot be predicted how microtunneling would affect the soil structure, roots of plants or water regime. The significant impact to priority habitats 6210* and 6280* (situated outside the Natura 2000 site) in the ALT EST 2 area can be avoided by ensuring construction activities do not take place in the immediate vicinity of these sites.

The impact of planned construction work on the bird species defined as the protection aim of the Natura 2000 birds site is insignificant to moderate. In order to limit moderate impact, it is necessary to apply mitigation measures. It is important to avoid negative impact on Black Guillemot (*Cepphus grylle*) whose only known nesting location in Estonia is located on the Pakri Peninsula within the impact area of ALT EST 2.

The project is estimated to have insignificant impact on the integrity of the Natura 2000 site.

In the Kersalu landfall location (ALT EST 1), where the plan is for the route to make landfall in a trench, the impact on the soil in the land section of the affected area will be significant. The microtunnel option (as planned for Pakrineeme in ALT EST 2) will cause minimum damage to the main feature in the Pakri Landscape Reserve, the Cambrian / Ordovician scarp of the Baltic Klint.

The mainland section of the Balticconnector will cover areas of very different sizes for the two alternative routes. ALT EST 1 with its 32-meter wide area directly under construction will cover around 3 ha, whereas ALT EST 2 with its direct construction zone (jacking shaft) will take up around 0.1 ha. While the ALT EST 1 route in Kersalu does not cross any protected objects of an area included in the preservation regime in force according to the environmental register, the ALT EST 2 landfall site is situated in the Pakri Landscape Reserve. However the seaward section of the route ALT EST 1 is situated within the planned Pakri Nature Reserve that has also been added to the environmental register. The ALT EST 1 area covers sites of 5 protected plant species (category III) and 17 animal species, and the ALT EST 2 area covers sites of 4 protected animal species.

Onwards from the landfall, the construction activities will have an impact on the habitats of protected species. This is described in more detail in section 6.6.5.

The impact of the mainland section of the pipeline on the natural environment can be divided according to the alternative construction methods – whether the pipeline will be taken to the mainland in a trench (ALT EST 1) or in a microtunnel (ALT EST 2). The construction of an open trench will have a greater impact than a closed construction method, which allows the pipeline to be brought to the mainland without touching the surface formations. It is important to plan ahead with regards to the various construction techniques to ensure the pipeline construction has less impact on natural formations. Mitigation measures can be employed to minimize impacts. For this, the protected plant species growing on the route of the ALT EST 1 alternative should be transplanted, and also the conditions should be improved for the species in the area of bushy alvar grassland bordered by the current site, improving its light conditions by cutting the brushwood.

Implementation of the Balticconnector project implements land use objectives provided in prior plans regarding both alternatives.

Impacts during operation

The impacts during the operation of the natural gas pipeline in coastal and marine areas will be low. Periodic inspections and servicing and maintenance tasks may cause minor disturbances to birds and marine mammals, but these will not differ from the disturbance caused by other movement in the area.

The Balticconnector gas pipeline will cover a strip of the seabed in the Gulf of Finland. The pipeline and the subsea rock installations protecting it will form a protrusion from the seabed in many places.

In normal situations there will be no impact on water quality during the operation of the natural gas pipeline. During operation, the impacts of the pipeline on the marine environment will mainly be restricted to minor flow amendments due to morphometric changes caused by the pipeline itself and its construction (covering and protection) in areas near the pipeline, such as increased turbulence around the pipeline at faster bottom flow velocities. Changes in flow velocities and directions may affect the transport and accumulation of materials in the close vicinity of the pipeline. According to measurements carried out for the Nord Stream project, impacts only extend up to tens of meters from the pipeline.

The flow of pressurized gas in the pipeline will increase the temperature of the pipeline, which will affect the bottom sediment up to a few meters from the gas pipeline. This change in temperature will not play any practical role as regards sediment characteristics. Pipeline maintenance measures will include the addition of soil around the pipeline wherever necessary. Such measures may contribute toward changes in near-bottom flows, whereby changes in flows may cause changes in erosion or sediment accumulation in nearby areas.

During pre-commissioning, underwater noise will be generated from water intake and discharge, in which pigging will also be used. Pipeline operation noise sources can be classified as either continuous or intermittent. During operation, noise will be generated by 1) gas-borne noise from pipeline and 2) maintenance works, such as the use of vessels and helicopters. Based on data from similar reports, the noise impact from these actions will, however, be insignificant.

After construction of the pipeline and the subsequent soil restoration is complete, the gaspipe corridor will be kept open by removing trees and bushes along the gas pipeline protection zone. This is the only impact element during operation and maintenance. Consequently, only herbs and shrubs can grow on the gas pipeline. It should also be noted that construction of the route corridor will create a new open habitat, and therefore construction may help open-habitat plants to distribute. The edge effect will not extend very far into the environment, and the zone that is kept clear of trees and shrubbery will not restrict the movement of animals or cause significant habitat changes for breeding birds.

Possible damage to the gas pipeline and resulting pipeline malfunction could have consequences to human safety. The risk assessment conducted for the Balticconnector project (*Ramboll 2014b*) identified the sections where the pipeline must be protected to prevent pipeline damage. Maintenance management of the gas pipeline will be carried out to ensure the pipeline will be kept in good working order and will not pose a risk to the environment.

Transboundary impacts across the borders of Estonia

The Balticconnector project is not estimated to cause significant transboundary impacts across the borders of Estonia. The pipeline will extend across western Gulf of Finland to Finland, whereby construction work in Estonian waters may result in low impacts in Finland's territorial waters. No impacts are estimated to occur on other Baltic Sea region states.

The deterioration of water quality arising from seabed interventions relating to the construction of the gas pipeline will be restricted in terms of area and duration. According to preliminary plans, the type of construction carried out near the limit of territorial waters, north of KP 53, will either be dredging or ploughing. Water works carried out in Estonian waters may cause some turbidity carried across the state borders. The contaminant contents found in sediment samples obtained from the Balticconnector pipeline route were, however, low, and their distribution with solids during construction is not likely to pose a risk to the marine environment. The Balticconnector project will not have significant transboundary impacts on water quality regardless of whether construction is carried out in Finnish or Estonian waters. Any low impacts taking place will be short-term and local.

Following the pressure test, the seawater used to flood the pipeline will be filtered and treated with oxygen scavengers and/or biocides. Flooding can also be carried out using clean water without any additives. When using oxygen scavengers or biocides, the water removed is led into a basin for the settlement of solids and any impurities in them. Following the settlement process, the water is pumped into a marine area where mixing will take place rapidly. If the flooding is carried out using filtered water, there is no need for settling and the water can be led in a controlled manner into the sea. If the flooding water of the Balticconnector pipeline is pumped into the marine area in Finland can possible adverse impacts to the water quality be considered as transboundary impacts. However, due to the small volume of water and the short duration of discharge, the impact of flooding water can be assessed as low on the basis of the experiences gained from the Nord Stream project.

Gas pipeline project activities taking place within the borders of Estonia during construction or operation are not estimated to have significant transboundary impacts on flora, birds, marine mammals or fish. Underwater blasting will take place in Estonian as well as Finnish territorial waters. The number of blasting sites will, however, be smaller on the Estonian side. Underwater noise from seabed dredging and possible blasting explosions may be carried from the limit of the Estonian territorial waters to Finnish territorial waters, whereby seals in the area may hear sounds caused by blasts. Underwater blasting causes brief and high levels of sound pressure transported over distances of tens of kilometers. As the distance from the blasting site increases, the impacts are reduced as the intensity of the sound decreases. Due to the large distance, however, there will not be significant noise impacts on the behavior of marine mammals. Above-water noise impacts will be low and short-term, and no significant transboundary impacts across Estonian borders are estimated to occur during project construction or operation.

The nearest Natura 2000 sites to the limit of Estonian territorial waters are the Kallbådan islets and waters and the Natura site of the Ingå archipelago, both at a distance of approximately 30 km. Balticconnector project activities on the Estonian side will not result in impacts on the protection principles of the Natura sites.

Seabed intervention will mainly result in temporary local impacts on other vessel traffic of a maximum duration of a few days for each area. In the offshore areas between Finland and Estonia where the pipeline will cross busy fairways, the safety zone will result in impacts on other vessel traffic as the diversion of the safety zone of the installation vessel will required during intervention measures. This is not estimated to have a significant impact on the safety of vessel traffic considering existing navigation and traffic control measures. Emissions from vessels participating in pipelaying will have an impact on air quality in the Finnish territory when the vessels are close to the Finnish territory. The impacts will be very low and remain close to the route taken by the vessels.

The transboundary impacts of the project on people and society will be low. There will be a temporary increase in technological and economic activity in Estonia and well as Finland during construction. During operation, there will be an emphasis in transboundary impacts on the territory of the two states on the role of the gas pipeline as an energy transport channel reducing dependency on Russian gas supply. The Balticconnector pipeline will not cause restrictions on bottom trawling, whereby there will be no impact on those who work in fisheries.

In a possible worst-case scenario accident in Estonian waters (gas pipeline rupture), the size of the dangerous flammable gas cloud would be slightly over 700 m and could result in a flash fire of the gas cloud and damage to people caught in the fire in the Finnish territory. However, a gas leak into the sea and the resulting formation of a gas cloud is a highly unlikely event.

Feasibility of alternatives and summary of comparison

As regards environmental impacts, the alternatives examined are feasible when special focus in project design is given to the prevention and mitigation of adverse impacts of pipeline construction. No adverse environmental impacts that are unacceptable or that could not be mitigated to an acceptable level were found during the environmental impact assessments of the project alternatives.

ALT EST 1 and ALT EST 2 both run across the shallow Lahepere Bay. There are no significant differences between the alternatives regarding the impact on seabed. ALT EST 1 will burden the seabed for a length of approximately 7 km, whereas ALT EST 2 will burden the seabed for a length of approximately 4 km.

Although the results of modeling resuspended particle spread indicated that floating material can spread quite far towards both shorelines in the bay, most of the material would settle in the immediate vicinity of the work area. A certain amount of sediment can be transported and settle outside Lahepere Bay toward the open sea from the tip of Ihasalu Peninsula only for ALT EST 2 in case of strong northwesterly winds.

In the area of ALT EST 1, soft and sandy sediment dominate on the sea bottom. The phytobenthic communities in this area are mainly formed by higher plants and have a high biomass value. In the shallow coastal sea area of ALT EST 2, a rocky type of seabed with characteristic communities of phytobenthos dominate. At a depth of 6–7 m, the rocky seabed gives way to sandy sediments with a lower biodiversity of seabed flora. In view of this, it can be assumed that by implementing this alternative there will be a lesser impact for phytobenthic communities because after completing construction work, rock filling would enable the recovery of the seabed flora characteristic to the region.

In the case of the alternative ALT EST 2 in Lahepere Bay, zoobenthos on both soft and hard compact substrata will be damaged. Alternative ALT EST 1 will see the damaging of benthic fauna communities only on the soft seabed, but the rock fill is planned to be deposited on a larger area. The zoobenthos is expected to recover after completion of construction work in both alternative construction areas if mitigation measures will be applied.

Changes to the seabed on the pipeline route can have a negative impact on the spawning grounds. Based on the distribution of most important species in Lahepere Bay, a smaller impact would be ensured by alternative ALT EST 1, which goes through an area where the number of species is lower than on the route of alternative ALT EST 2. In general, the area of the planned gas pipeline is small when compared to the area of the bay, and it is probable that the impact caused by changes on the seabed on the spawning areas of Baltic herring (*Clupea harengus membras)* as well as other fish is insignificant for both alternatives.

Both onshore alternative routes have an impact on protected natural objects. The ALT EST 1 area covers sites of five protected plant species (category III) and 17 animal species, and ALT EST 2 area covers sites of four protected animal species.

The impact of the mainland section of the pipeline on the natural environment can, in turn, be divided according to alternative construction methods – whether the pipeline will be taken to the mainland in a trench (ALT EST 1) or by building a microtunnel (ALT EST 2). Construction methods that damage natural environments the least have a lesser impact on natural communities and biotopes.

ALT EST 1 is in line with the thematic plan of the comprehensive plan of Paldiski titled "Location of the category D natural gas pipeline" and ALT EST 2 with Paldiski LNG terminal detailed land use plan. There is still uncertainty regarding the connection of ALT EST 2 with the Paldiski-Kiili category D natural gas pipeline. In order to create this connection, an approximately

8.5-km long natural gas pipeline must be constructed from ALT EST 2 to the planned compressor station in Kersalu.

The project is estimated to have insignificant impact on the integrity of the Natura 2000 site.

ALT EST 1 is assessed as having less impact than ALT EST 2 on the Pakri Habitats Directive site.

The overall significance of the implementation alternatives assessed is shown in the table below (Table 1-1).

Table 1-1. Assessment scale for the assessment of the significance of impacts and the significance of the environmental impacts of the implementation alternatives of the Balticconnector project assessed (ALT EST 1 and ALT EST 2) in comparison with the current situation and the non-implementation of the project (zero alternative).

Significance of impacts	Very high ++++
	High +++
	Moderate ++
	Low +
	No impact
	Low -
	Moderate --
	High ---
	Very high ----

Project's environmental impacts	ALT 0	Construction		Operation	
		ALT EST 1	ALT EST 2	ALT EST 1	ALT EST 2
Seabed	0	-	-	-	-
Water quality	0	- -	- -	-	-
Benthic fauna and aquatic flora	0	-	-	0	0
Fish fauna	0	- -	- -	0	0
Fishing	0	- -	- -	0	0
Conservation areas	-	- -	- - -	0	0
Flora	0	- -	- - -	-	-
Bird fauna	0	- -	- -	0	0
Other fauna	0	- -	- -	0	0
Soil, bedrock and groundwater	0	- -	-	0	0
Noise	0	-	-	0	0
Vibrations	0	-	-	0	0
Waterborne transport	0	-	-	-	-
Land transport	0	-	-	-	-
Air emissions	0	-	-	0	0
Land use and built environment	0	-	-	0	0
Landscape and cultural environment	0	-	-	-	-
People and society	0	-	-	+	+
Natural resources	0	0	0	-	-
Waste	0	0	0	0	0

In addition to adverse impacts, implementation of the project will also have positive environmental impacts. Natural gas for Estonia is currently sourced only from Russia and Latvia. Construction of the Balticconnector natural gas pipeline would contribute to the development of the natural gas market and supply security in Estonia. If the project is not implemented, neither the adverse nor the positive impacts of the project will be realized.

GLOSSARY

AIS Automatic Identification System (used for vessel traffic registration in the Baltic Sea)

ALT Alternative

ALT EST 1 Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, with the point of landfall in Kersalu, Estonia.

ALT EST 2 Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, with the point of landfall in Pakrineeme, Estonia.

ALT FIN 1 Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, route north of Stora Fagerö.

ALT FIN 2 Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, route south of Stora Fagerö.

Alvar A biological environment based on a limestone plain with thin or no soil and, as a result, sparse grassland vegetation.

Argillite A fine-grained sedimentary rock composed predominantly of indurated clay particles.

Barg A unit of pressure expressing the pressure above atmospheric pressure.

BDT Behavior Disturbance Threshold

BIAS Baltic Sea Information on the Acoustic Soundscape

BSPA Baltic Sea Protected Area

CE Critically Endangered

CHP Combined heat and power plant

Compressor station Compressor stations are used to raise gas pressure and that way increase the natural gas transmission network capacity.

CPA Closest point of approach

DP Dynamically positioned

ECA Estonian Competition Authority

EELIS Estonian Nature Information System

EEZ Exclusive Economic Zone – sea zone in which a state has special rights over the exploration and use of marine resources

EIA Environmental impact assessment

EIA programme The EIA programme (scoping document) highlights the potential environmental and socioeconomic components that may be impacted upon during a certain timeframe and over a certain distance

EN Endangered

EQR Ecological quality ratio (ratio between the measured value and water quality criteria

Espoo Convention The Convention on Environmental Impact Assessment in a Transboundary Context

Euphotic zone A layer of a body of water that is exposed to sufficient sunlight for photosynthesis, also called 'photic zone'

FEED Front End Engineering Design

GES Good environmental status

GOFREP The Gulf of Finland Reporting System for vessel traffic

Halocline A strong vertical salinity gradient within a body of water

HDD Horizontal directional drilling

HELCOM MPA A Marine Protected Area (MPA) under the Baltic Marine Environment (formerly Baltic Sea Protected Areas- BSPAs). Protection Commission (HELCOM).

HIROMB High Resolution Operational Model for the Baltic Sea

Horizontal drilling Also called horizontal directional drilling (HDD) or directional boring, this is a subsurface installation method for natural gas pipelines that does not require open-cut installation. A pilot hole is drilled using a drill bit with directional control, which is then enlarged to reach the sufficient diameter to accommodate the subsurface pulling of the pipeline without surface intervention.

IBA Important Bird and Biodiversity Area

IBSFC The International Baltic Sea Fishery Commission

ICES statistical rectangle The ICES has divided marine areas into ICES divisions and ICES subdivisions. The Baltic Sea is located in ICES subdivisions 22–32, and the Gulf of Finland is in subdivision 32. The divisions are further divided into statistical rectangles (approximately 55 km x 55 km) with two parallel numbering systems, the one used by the ICES and the one used by the State of Estonia.

ICES The International Council for the Exploration of the Sea

IMO The International Maritime Organization

IUCN The International Union for Conservation of Nature and Natural Resources

KP Kilometer Post

LCA Limited Conservation Area

LEL Lower explosive limit

LF Landfall

LF1 Alternative point of Landfall in Finland - landfall of the Balticconnector natural gas pipeline north of the Fjusö Peninsula in the Bastubackaviken Bay area.

LF2 Alternative point of landfall in Finland - landfall of the Balticconnector natural gas pipeline on the Fjusö Peninsula.

LNG Liquefied natural gas. Natural gas remains in liquid form in normal atmospheric pressure if its temperature is around −163 °C.

Longline Offshore fishing gear used to catch salmon. Net length usually around 20 km (1,000 hooks).

MARPOL Convention International Convention for the Prevention of Pollution From Ships

MCDA Multi-criteria decision analysis

MEAC Ministry of Economic Affairs and Communications

MFA Ministry of Foreign Affairs

MoE Ministry of the Environment

MTBM Microtunnel Boring Machine
Natura 2000 Network of areas designated to conserve natural habitats and species of wildlife in the European Community

Natura assessment Assessment of potential environmental impacts on Natura 2000 network.

NECA Nitrogen Oxide Emission Control Areas

NDT Nondestructive testing

NLP Noise Level Point

NT Near Threatened

PCI European Union's list of Projects for Common Interest

Pelagic Living in offshore or open water areas

PPV Peak particle velocities

PTS Permanent Threshold Shift

RL Received level

RMK State Forest Management Centre

ROV Remote Operated Vehicle

SEA Strategic environmental assessment

SECA Sulfur oxide emission control area

S-lay method Refers to the shape that the pipe forms as it is lowered onto the seabed.

SL Source level

SSS - Sidescan sonar A device that creates an image of the sea floor

Sub-bottom profiler A powerful low-frequency echo-sounder providing profiles of the upper layers of the sea bottom.

TEN-E Trans-European energy network

Territorial waters A belt of coastal waters extending at most 12 nautical miles from the baseline (usually the mean low-water mark) of a coastal state.

Thermocline A steep gradient of rapid temperature change in a body of water.

TL Transmission Loss

TSO Transmission System Operator

TTS Temporary Threshold Shift

Turbidity Loss of clarity in water caused by the presence of suspended silt or organic matter.

UEL Upper explosive limit

UNECE United Nations Economic Commission for Europe

UNESCO United Nations Educational, Scientific and Cultural Organization

USBM United States Bureau of Mines

Usufruct An easement-like right to use an area in a piece of real estate owned by another party. This provides Gasum with rights including the transmission of natural gas and the maintenance of the pipeline.

UXO Unexploded ordnance.

VASAB Long-Term Perspective for the Territorial Development of the Baltic Sea Region.

VOC volatile organic compound

VU Vulnerable

2 DESCRIPTION OF THE PROJECT

2.1 Project developers

The Project Developers in the environmental impact assessment (EIA) procedure for the Balticconnector project are the Finnish Gasum Corporation and the Estonian AS EG Võrguteenus.

The Gasum Group consists of the parent company, Gasum Corporation, and the subsidiaries Gasum Paikallisjakelu Oy, Gasum Energiapalvelut Oy, Gas Exchange Ltd, Helsingin Kaupunkikaasu Oy, Gasum Tekniikka Oy and Gasum Eesti AS. Under the natural gas network license obtained by Gasum, the company has been designated to have responsibility for the technical functioning and reliability of the natural gas transmission system and to perform the duties related to balance responsibility for the transmission system in a manner that is appropriate and equal in respect of the parties to the natural gas market (system responsibility). Gasum has been appointed as the Finnish Transmission System Operator (TSO).

AS EG Võrguteenus, the Estonian Transmission System Operator, was founded in December 2005 on the basis of the legal obligations issued by the Republic of Estonia and the European Union.

AS EG Võrguteenus began its economic activities on January 1, 2006 as an independent natural gas transmission and distribution service company operating in Estonia. Since August 2013, AS EG Võrguteenus has been solely responsible for natural gas transmission services as the national TSO.

2.2 Purpose of the project

The purpose of the Balticconnector natural gas pipeline project is to interconnect the Finnish and Estonian natural gas distribution networks. The integration of the Finnish and Estonian gas infrastructures will ensure a more coherent and diverse natural gas network in the Baltic Sea region and guarantee the security of natural gas supply for the northeastern Member States of the EU. The offshore pipeline will enable gas transmission between Finland and Estonia while also providing the opportunity to utilize the underground natural gas storage facilities in Latvia. The flow of gas can take place in both directions, making it also possible to transmit natural gas from Finland to Estonia.

In Finland the Balticconnector pipeline will be connected to the Gasum natural gas network via a pipeline section to be constructed from Ingå to Siuntio. In Estonia the Balticconnector pipeline will be connected to the Estonian natural gas network via the planned compressor station and the pipeline section to be constructed in Kiili. The connection of the Balticconnector pipeline to a regional LNG terminal will create an integrated natural gas network for the Baltic states and Finland. The offshore natural gas pipeline project can also be justified from the supply security perspective. Potential combined impacts of the LNG terminal and the Balticconnector project are discussed in Chapter 6.11 of this report.

2.3 Project background

Finland has imported natural gas from Russia since 1974. The length of the current Finnish gas pipeline network is more than 1,000 kilometres. The annual consumption of gas is approximately 3.5 billion m³, corresponding to 8.5% of Finland's total energy consumption. Gasum has been the only importer of gas to Finland since 1994.

The imports of gas are based on an agreement between Gasum and OAO Gazprom valid until 2025.

Estonia imports natural gas from Russia and the Inčukalns underground gas storage facility in Latvia. Gas is transmitted to customers via pipelines, distribution stations and pressure reduction stations. The Eesti Gaas Group is the leading natural gas distributor in Estonia (with a share exceeding 90% of the retail market) via the following Group companies: AS Eesti Gaas, AS EG Ehitus and AS Gaasivõrgud. According to the economic indicators published by Eesti Gaas for 2013, the volume of natural gas sold by the company totaled almost 582 million m³. Of this, 79% was sold to consumers (including industry) and 10% to residential customers.

Access to and supply security of natural gas and, consequently, the consumption of natural gas in Finland and the Baltics can be considerably improved by new alternative natural gas transport routes. The Balticconnector is classified in the guidelines for trans-European energy networks (TEN-E) as a priority project and has been granted financial assistance by the EU. Part of the funding has been used for the pipeline's preliminary technical design, geotechnical and geophysical studies and environmental surveys. The studies and surveys conducted during the project are described in Chapter 6.3.

It was found on the basis of the natural gas network capacity surveys conducted during the project that most of the capacity of the natural gas pipelines extending from Western Russia via the Baltic states to Finland is in use. Free capacity to serve the Finnish needs is only available occasionally. Correspondingly, occurrences of low capacity have also been experienced in supply to cater for Estonia's own demand for natural gas. Therefore explorations were launched into the opportunity to transmit gas via Finland to Estonia and possibly also to the other Baltic states. The opportunity of bidirectional natural gas transmission is the basic requirement for the implementation of the project.

2.4 Route alternatives

2.4.1 Previously studied route alternatives

Alternative routings for the Balticconnector project have been explored since the early 2000s (Figure 2–1). These studies were based on the utilization of existing data. In Finland, points of landfall examined in addition toIngå include the Kopparnäs area in Ingå, Suomenoja in Espoo, Vuosaari in Helsinki and Kilpilahti in Porvoo. In Estonia, the areas considered for the landfall have been Muuga and Paldiski. First to be examined in the feasibility studies on the alternatives was the relationship of the landfall sites to the natural gas network. These examinations resulted in the shortlisting of the above-mentioned points of landfall. Further examination of the alternatives focused on any restrictions arising from land use in the areas, restrictions relating to the offshore areas, and the length of each route. The following objectives were set for the comparison and shortlisting of routes:

- minimizing the length of the pipeline;
- avoiding special areas;
- maintaining a sufficient safety distance from the built environment;
- avoiding cables, wires and wrecks;
- avoiding fishing areas, marine sand extraction areas, military areas, wind parks and anchoring areas;
- avoiding unfavorable seabed areas;
- avoiding marine transport routes.

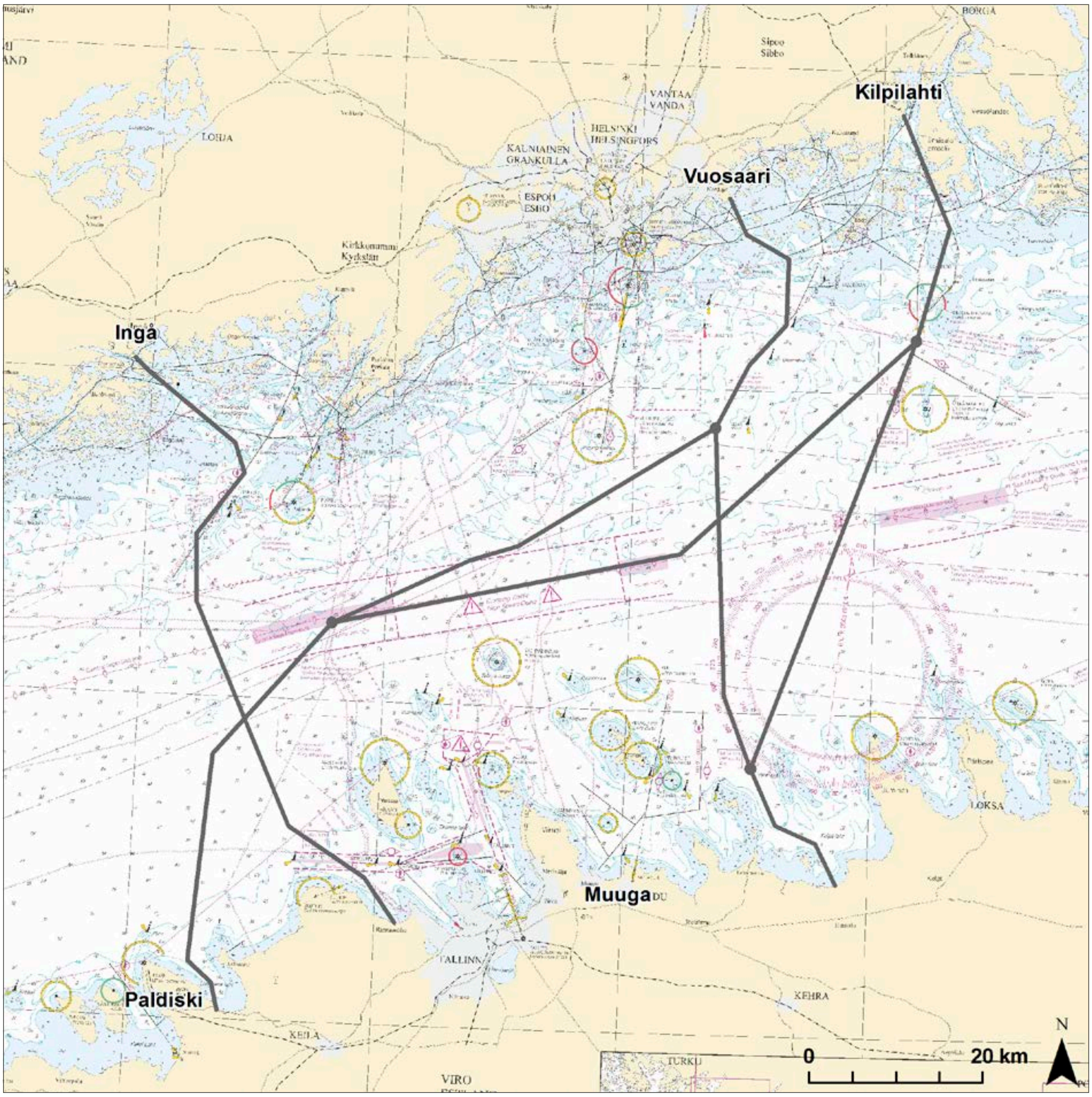


Figure 2–1. Previously studied route alternatives and the respective landfalls.

The Estonian landfall at Muuga was rejected in the further examinations due to the intensive land use in the areas. In Finland the Kopparnäs, Suomenoja and Kilpilahti landfall points were not included in further examinations.

Kilpilahti was rejected because the pipeline would be more than 100 kilometres in length and run through a military firing area, a nature reserve and, for more than six kilometres, through inner archipelago. The pipeline would also cross several cables and run along the main fairway of the Gulf of Finland over a considerable distance. The selection of this pipeline route would have required the placement of the Estonian landfall east of Tallinn in Muuga. Muuga is not suitable as a landfall for land use planning reasons.

Vuosaari, Helsinki, was rejected as a landfall due to the land use in the area. Land use around the Vuosaari Harbor is intensive, and there is no suitable site available for a compressor station in the area. The Vuosaari Harbor area and sea lane also make the offshore area limited in space, whereby it would be a demanding task to install the pipeline alongside the sea lane. There are also lots of islands and rocks off Vuosaari. The offshore pipeline from Vuosaari to Paldiski would also be very long, around 126 kilometres in total.

Suomenoja was rejected as a landfall due to the area's intensive land use plans. A new, densely built urban residential area is being planned for the Suomenoja area, which also involves land reclamation and harbor development. The Suomenoja landfall would also have required the routing of the offshore pipeline east of the Helsinki caisson lighthouse, which would extend the offshore section considerably to around 120 kilometres.

Kopparnäs was not included in the further examinations due to the difficult construction conditions on the Finnish side and the current and planned land use in Kopparnäs and along the Kopparnäs – Siuntio natural gas pipeline. The pipeline would also have to be installed in the archipelago over a considerable distance off Kopparnäs.

The restrictions and other grounds for rejection of the previously studied route alternatives are presented in the Table 2-1.

Table 2-1. Alternative routes for the Balticconnector project and their restrictions.

Route	Offshore pipeline length, km	Onshore pipeline length, km	Restrictions and other justifications
Muuga-Kilpilahti	107	1	Not possible to coordinate with land use in Muuga area
Muuga-Vuosaari	91	3	Offshore section short, not possible to coordinate with land use in Muuga area
Muuga-Suomenoja	86	0	Offshore section short, not possible to coordinate with land use in Muuga area
Paldiski-Kilpilahti	148	1	Offshore section very long, located along the main fairway of the Gulf of Finland, dense archipelago off Kilpilahti.
Paldiski-Vuosaari	126	3	Long offshore section, dense archipelago off Vuosaari, not possible to coordinate with land use in Vuosaari.
Paldiski-Suomenoja	119	0	Long offshore section, very difficult to coordinate with future land use in Suomenoja.
Paldiski-Kopparnäs	90	10	Short offshore section, difficult offshore construction conditions near the coast, difficult to coordinate in terms of land use.
Paldiski-Ingå	81	30	The shortest offshore section, can be coordinated with land use.

2.4.2 Assessed alternatives in the EIA procedure

On the basis of the examinations presented above, the Ingå– Paldiski offshore pipeline has been selected for the EIA procedure. The selection was based on the pipeline route featuring the shortest offshore section and the fact that the natural gas pipeline and the compressor station can in both countries be coordinated with the land use in the area. There are no wind parks planned for the offshore section. The project is not in conflict with the operations of the Defence Forces. Crossings of the main fairway of the Gulf of Finland have been minimized as the pipeline route runs perpendicular across the fairway.

Several factors were taken into consideration in the determination of the current route of the offshore natural gas pipeline (Ingå – Paldiski), including route length, existing natural gas network, local areas, regulations and guidelines concerning land use planning, fairways, military areas, anchoring areas, geophysical characteristics and bathymetry. The geotechnical and geophysical surveys along the offshore pipeline route we conducted by Marin Mätteknik AB in 2006 and 2013 *(MMT 2006 and 2014)*. Other studies and surveys conducted during the project are described in Chapter 6.3.

The technical design of the project has progressed to the preliminary technical design phase *(Ramboll 2014a)* which has involved the optimization of the pipeline route within the corridor studied (study corridor that is 275–975 metres wide, *MMT 2006* and *2014*) to minimize seabed intervention, pipeline length and curvature.

In Estonia the Paldiski area has been selected as the point of landfall. AS Eesti Gaas has made plans to expand the current Estonian gas pipeline network west of Tallinn all the way to the City of Paldiski. The assessment of the gas pipeline route from Kiili to Paldiski running south of Tallinn was carried out in conjunction with the strategic environmental assessment (SEA) included in the statutory land use planning process. The impacts of the compressor and reception station to be constructed in Paldiski (Kersalu) were also assessed in conjunction with the SEA. According to the preliminary plans, the Balticconnector natural gas pipeline will be connected to the Estonian gas pipeline network via the compressor station planned for Kersalu. The municipality of Paldiski launched the detailed plan procedure for the compressor station on May 23, 2012 and adopted it on 20 October 2014.

In Finland, Ingå has been selected as the point of landfall. In 2007 a decision was made by Gasum to invest in a new natural gas pipeline between Mäntsälä and Siuntio following the investment decision of Fortum Corporation concerning a new natural gas-fuelled combined heat and power (CHP) plant in Suomenoja, Espoo. The added capacity provided by the new natural gas pipeline has primarily covered the increased gas consumption at the Suomenoja power plant but also considerably improved the supply security of natural gas in the entire Helsinki Metropolitan Area and enabled access to natural gas in new areas in western Uusimaa. This investment decision by Gasum also supports the decision to focus the development of the Balticconnector project exclusively on the Ingå- Paldiski alternative. The Balticconnector and the LNG terminal being planned at the same time will be connected to the Finnish natural gas network with the Ingå- Siuntio natural gas pipeline section planned by Gasum.

The figure (Figure 2–2) presents the existing gas pipeline connections in the Gulf of Finland region and the preliminary routing of the Balticconnector natural gas pipeline.

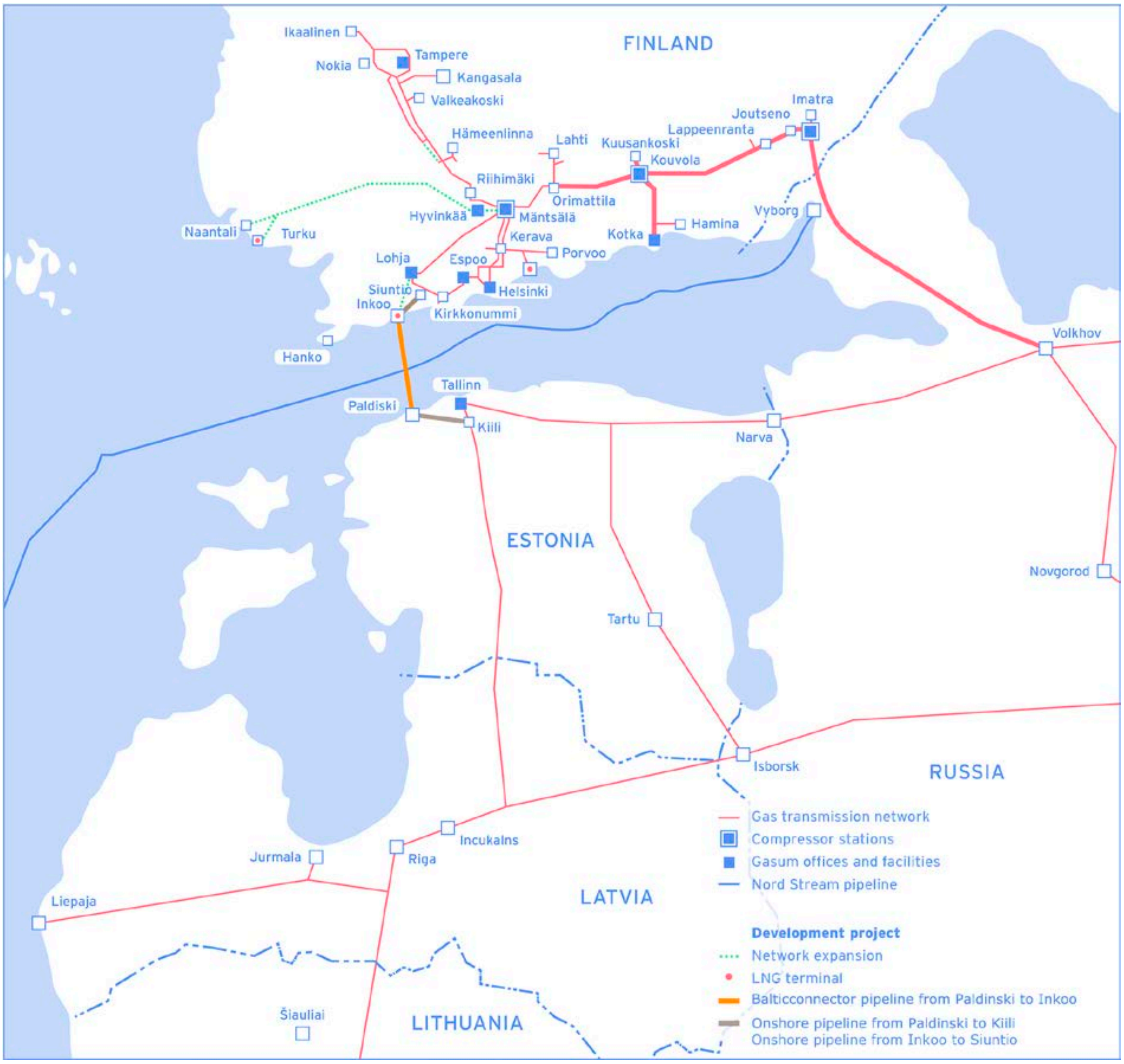


Figure 2–2. Natural gas pipeline network in the Gulf of Finland region.

This EIA report covers the preliminary route of the offshore Balticconnector natural gas pipeline from Ingå, Finland, to Paldiski, Estonia, and the related routing alternatives in Finland and Estonia. The following alternatives have been examined in the environmental impact assessments conducted (Figure 2–3):

- **Alternative EST 1 (ALT EST 1)**: construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, point of landfall in Kersalu, Estonia.
- **Alternative EST 2 (ALT EST 2)**: construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, point of landfall in Pakrineeme, Estonia.
- **Alternative FIN 1 (ALT FIN 1)**: construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, route north of Stora Fagerö.
- **Alternative FIN 2 (ALT FIN 2)**: construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Ingå, Finland, to Paldiski, Estonia, route south of Stora Fagerö.

In addition, two alternative points of landfall and the respective natural gas pipeline routings in Ingå have been examined:

- **Landfall 1 (LF1):** landfall of the Balticconnector natural gas pipeline north of the Fjusö Peninsula in the Bastubackaviken bay area.
- **Landfall 2 (LF2)**: landfall of the Balticconnector natural gas pipeline on the Fjusö Peninsula.

A situation where the Balticconnector natural gas pipeline will not be constructed is assessed as the zero alternative.

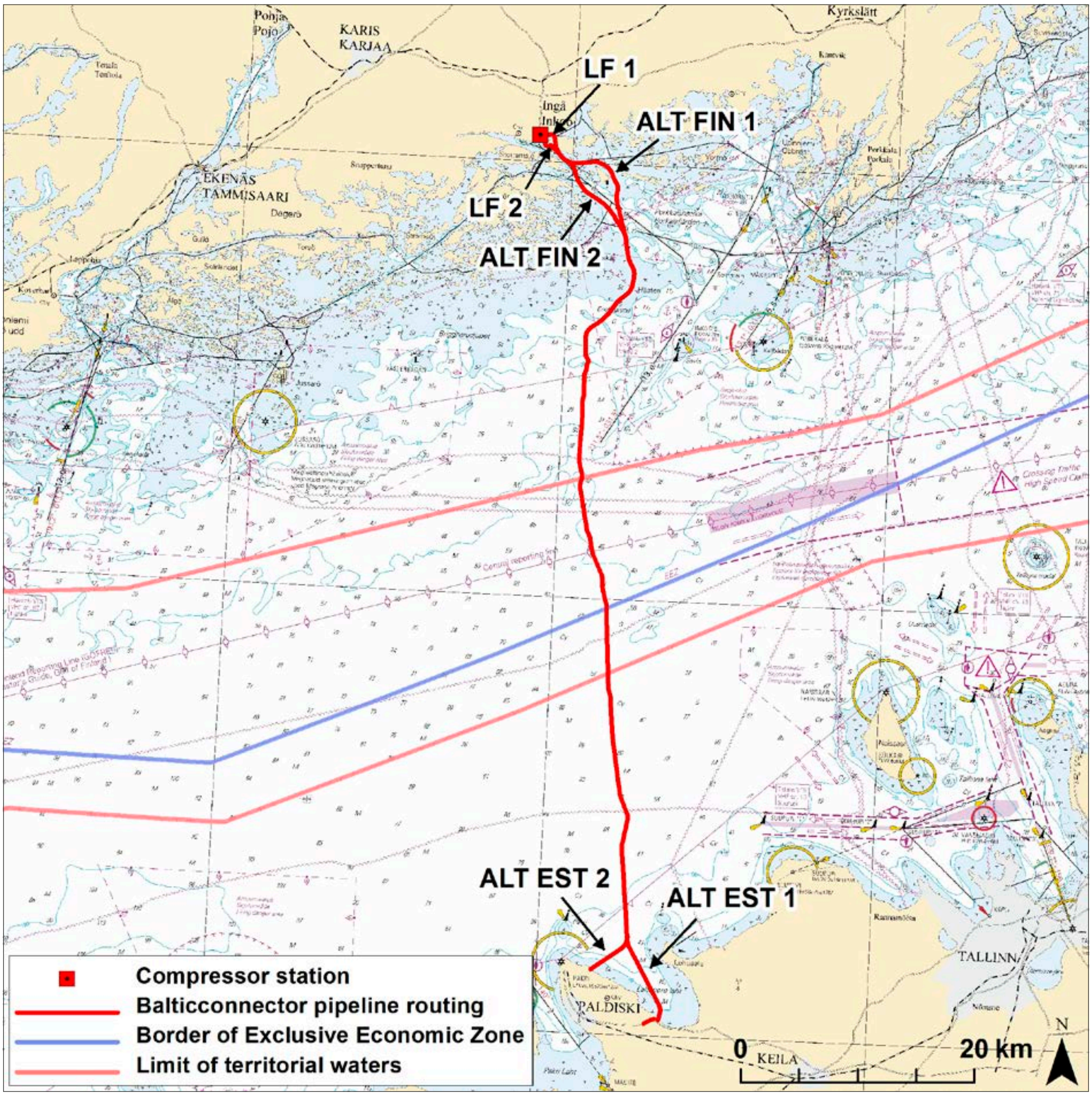


Figure 2-3. The routing alternatives of the Balticconnector natural gas pipeline.

2.4.2.1 Route alternatives in Estonia

Two possible alternative points of landfall have been assessed on the Pakri Peninsula: Kersalu (ALT EST 1) and Pakrineeme (ALT EST 2) (Figure 2-4 and Figure 2-5).

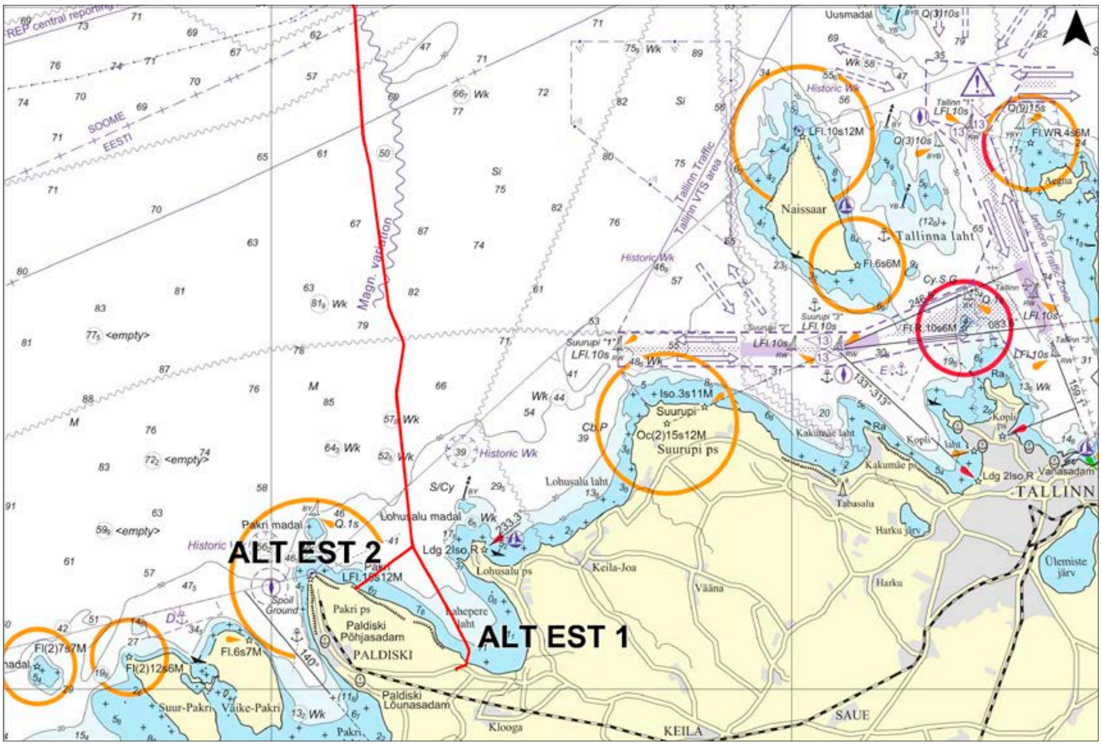


Figure 2-4. The routing alternatives of the Balticconnector natural gas pipeline in Estonia.

The sea area surrounding the Pakri Peninsula (excluding the waters off the Paldiski harbors) is included in the Pakri Natura 2000 area.

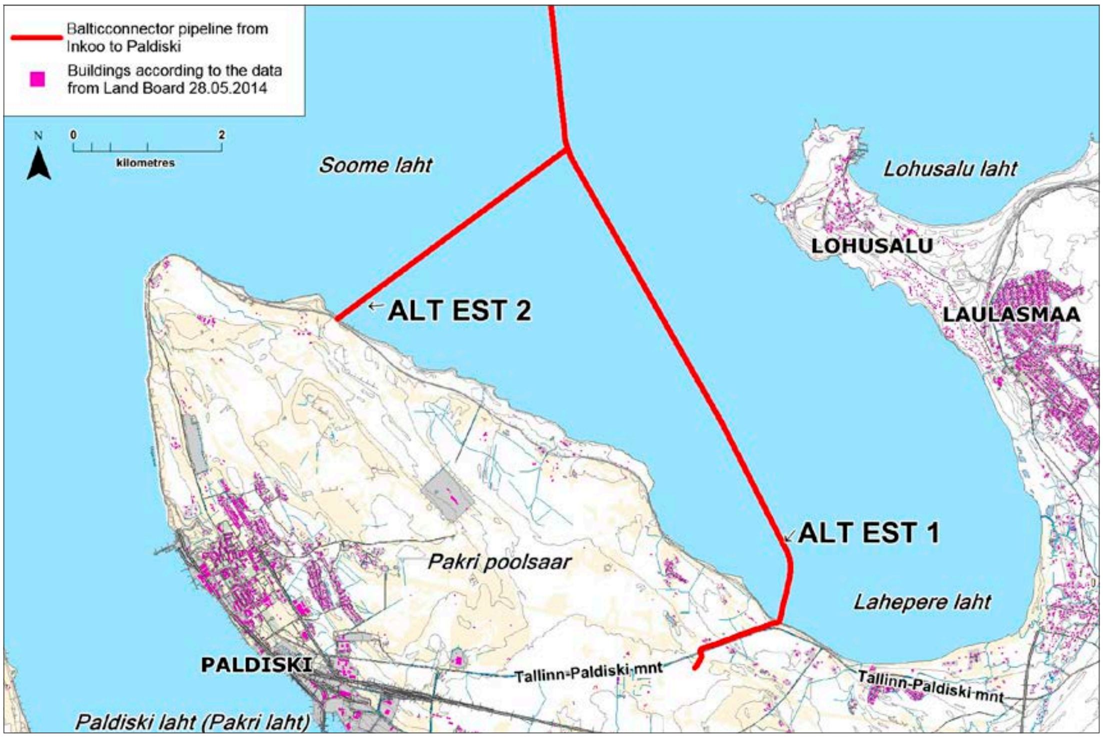


Figure 2-5. The routing alternatives of the Balticconnector natural gas pipeline in Estonia.

Figure 2–6. The routing alternatives of the Balticconnector natural gas pipeline in Finland.

In the ALT EST 1 area the landfall is located in the shallow Lahepere Bay, Kersalu, Paldiski, close to the border between the municipalities of Paldiski and Keila. The distance from the point of landfall to the center of the municipality of Paldiski is around 6.5 km and to Tallinn around 50 km. Alternative ALT EST 1 planned at Kersalu will include a more than one kilometre long mainland section of the pipeline running parallel to Tallinn Paldiski highway through forest and three alvar areas. There are three farmsteads around the on-ground section of the gas pipeline ALT EST 1 from the point of landfall to the compression station.

The landfall of the ALT EST 1, the natural gas pipeline routing from the landfall to the compressor station, and the location of the compressor station are specified in the thematic plan included in the comprehensive plan of the City of Paldiski entitled "Location of category D natural gas pipeline within the City of Paldiski" approved by the local council of the City of Paldiski on December 22, 2012 *(K-Projekt AS 2012)*.

The landfall of the ALT EST 2 alternative is located in the municipality of Paldiski on the northeastern shore of the Pakri Peninsula in conjunction with the LNG terminal site planned for Paldiski. The alternative is located on the Pakri klint where the limestone scarp is more than 1824 m high. The landfall site is dominated by relatively valuable meadows and deciduous-dominated forests on rocky terrain. A reception station will be constructed

Figure 2–7. Landfall alternatives, including the respective natural gas pipeline routings, in Ingå.

in the vicinity of the landfall, with the option of further constructing a connection to the Estonian natural gas network.

The seabed is more even in the Paldiski area than off the Finnish coast. Water depth already drops to around 20 m at 3.5 km from the shoreline. A more detailed description of the vertical profiles for the alternatives can be found in Chapter 5.1.1.

2.4.2.2 Route alternatives in Finland

Two route alternatives have been studied in the vicinity of the Port of Ingå. The ALT FIN 1 alternative passes the island of Stora Fagerö from the north and the east and crosses the fairway southeast of Stora Fagerö at a point where the fairway is wide and relatively deep. The ALT FIN 2 alternative crosses the fairway west of Stora Fagerö closer to the Port of Ingå and runs between Stora Fagerö and Älgsjö towards the south (Figure 2–6).

After crossing the fairway, ALT FIN 2 runs parallel to the fairway for several kilometers. Water depth at the intersection of the fairway and the natural gas pipeline route alternatives (ALT FIN 1 and ALT FIN 2) is approximately 23–30 m. ALT FIN 1 is around 1.3 kilometres longer than ALT FIN 2. The routes come together before passing west of the Hästen lighthouse. From there the route runs into the deeper parts of the outer archipelago towards Estonia, passing the Enoksgrund shallow from the east.

The landfall alternatives (LF1 and LF2) are located in Ingå north of the Fjusö Peninsula in the Bastubackaviken area and on the Fjusö Peninsula (Figure 2–7) around two kilometres northeast and east of the Port of Ingå, in north of theIngå sea lane. The landfalls and underground natural gas pipeline routings as well as areas directly connected with them are mostly fenced off. The fenced area relates to the activities of the National Emergency Supply Agency, and access to the area is restricted. The area is not currently used for residential or holiday accommodation, recreation or other public or private access. The area is mostly covered by forest.

2.4.2.3 Zero alternative

The zero alternative means a situation where the Balticconnector natural gas pipeline will not be constructed. In this alternative the LNG terminal planned for Ingå will not be constructed either, and the positive and negative environmental impacts of both projects will not be realized.

The Balticconnector natural gas pipeline and the LNG terminal would diversify and increase competition in natural gas sourcing. In the zero alternative, this objective of the projects to provide the market with less expensive, more price-stable and competitive natural gas would not be achieved and natural gas would be replaced by other fuels. For a more detailed description of the impacts of the zero alternative see chapter 6.10.

3 TECHNICAL DESCRIPTION OF THE PROJECT

3.1 Project design stages

In the EIA procedure phase of the Balticconnector project, technical design has progressed to the preliminary technical design phase, on which the project's design and technical data described in this chapter are based *(Ramboll 2014a)*.

The field and environmental studies conducted during the project are described in Chapter 6.3. The overall schedule of the Balticconnector project is shown in the table (Table 3-6).

Preliminary assessments of the need for seabed intervention were carried out in the stage preceding the Front End Engineering Design (FEED) stage. Off the Finnish coast in particular, the seabed is very uneven and the need for intervention high. In the FEED stage pipeline route optimization will continue, which is likely to reduce the need for seabed intervention from the levels presented in this EIA report.

A pipeline Kilometer Post (KP) system has been established for the entire Balticconnector pipeline. For the offshore pipeline, KP 0.000 has been set at the tie-in weld between the offshore and onshore pipeline at the landfall in Ingå, Finland. The KP numbering increases towards the south (Figure 3-1).

3.2 Properties of natural gas

Natural gas is a fossil fuel which, due to its low carbon and high hydrogen content, produces less carbon dioxide (CO_2) emissions than other fossil fuels when combusted. The specific emission of carbon dioxide from gas combustion is 55 g/MJ, while the figures for coal and peat are 95 g/MJ and 106 g/MJ, respectively. Natural gas is also practically sulfur-free, does not cause particulate emissions and its nitrogen oxide emissions are clearly below those of other fossil fuels.

Natural gas is odorless, colorless and non-toxic and does not cause corrosion. It has a narrow flammability range with air and a high ignition temperature. If there is a leak, natural gas vaporizes immediately and evaporates into the air, and it does not mix with seawater. The assumed natural gas composition in the Balticconnector pipeline is shown in the table below (Table 3-1). The composition is presented as a typical, however, it may vary slightly depending on whether the gas comes from the LNG terminal or the gas network.

Table 3-1. The typical natural gas composition in Estonian gas network (*EG Võrguteenus 2015*).

Component	Mole (%)
Methane (CH_4)	96.693
Ethane, C_2H_6	1.745
Propane, C_3H_8	0.499
n-butane, n-C_4H_{10}	0.077
2-methylpropane $CH_3CH(CH_3)CH_3$	0.079
Nitrogen, N_2	0.785
Carbon dioxide, CO_2	0.090
2,2-dimethylpropane $CH_3C(CH_3)2CH_3$	0.001
2- methylbutane $CH_3CH(CH_3)CH_2CH_3$	0.014
n-pentane, n-C_5H_{12}	0.009
C_6+	0.008

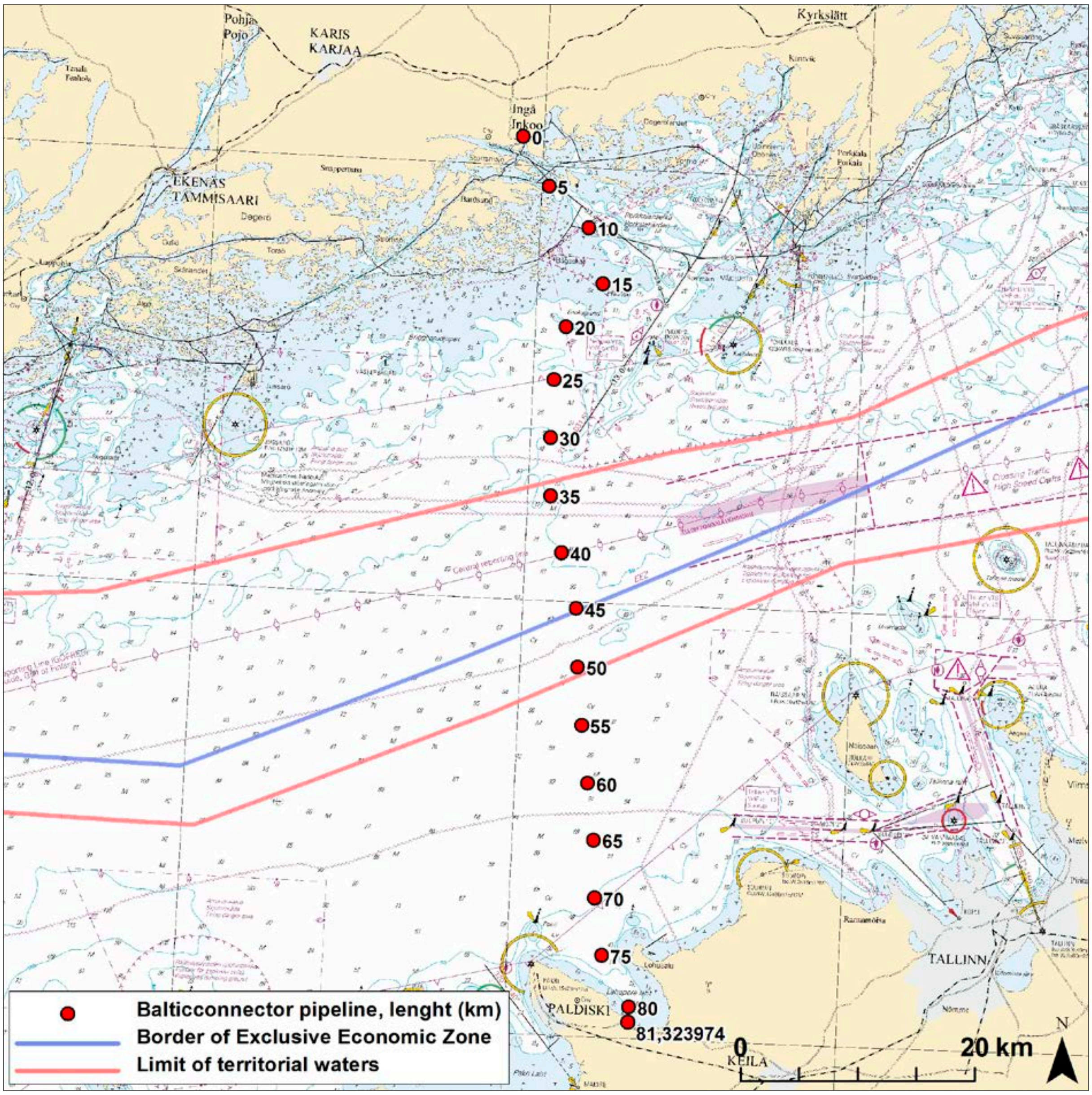


Figure 3–1. Kilometer Posts (KP) along the Balticconnector pipeline route (Ramboll 2014c).

3.3 Technical characteristics of the natural gas pipeline

The Balticconnector pipeline's length will be approximately 81 km and diameter 508 mm. Its capacity will be around 7.2 million m³/day, i.e. around 300,000 Nm³/h. The design pressure for the pipeline is 80 barg. The pipeline's operational life is expected to be 50 years.

The pipeline will be constructed from carbon steel line pipes, each 12.2 m in length, which will be welded together. The thickness of the steel line pipes is based on the maximum allowable operating pressure, prevention of external collapse and resistance to external impact. According to preliminary calculations, the wall thickness for the Balticconnector line pipes will be 12.7 mm, which is sufficient to protect the pipeline against collapse during construction, whereby separate support structures will not be needed.

3.3.1 Pipeline coating

Anti-corrosion coating

To reduce friction and improve flow conditions, the line pipes will be internally coated at the pipe manufacturing site with an epoxy-based material covering the entire pipeline length.

An external coating will also be applied at the pipe manufacturing site using a three-layer polyethylene coating or, alternatively, an asphalt enamel coating. The pipeline will be coated over its entire length, except for the welded cutbacks at the end of the pipes (Figure 3–2).

The manufacturing site of the line pipes is not yet known at this point in project design.

Figure 3-2. Line pipe with a (black) polyethylene coating inside a concrete coating (Ramboll 2014c).

Concrete coating

The line pipes will be coated over their entire length, excluding their ends (the joints welded together on the pipelaying vessel), at a concrete coating facility to provide them with stability against hydrodynamic loading caused by waves and currents during construction and usage. The concrete coating will also protect the pipeline against damage caused by fishing gear, such as trawls. The concrete will comprise a mix of cement suitable for marine use, water and aggregate such as crushed rock or gravel as well as iron ore aggregate added to the mixture. The concrete coating will also be reinforced with steel cages. According to preliminary plans, the line pipes for the Balticconnector project will be coated at an existing northern-European concrete-coating facility.

The line pipes will be welded together on the pipe-laying vessel. After welding, the field joints will be insulated with a (polyethene) heat-shrink sleeve and polyurethane foam, which will protect the field joints against damage such as fishing trawl impact. The total consumption of pipeline coating system and insulation materials is shown in (Table 3-2) the table below.

3.3.2 Protection against corrosion

In addition to the (passive) anti-corrosion systems, the pipeline will also be provided with an active protection system consisting of galvanic aluminum anodes. The anodes will be attached to the pipeline during the concrete coating process at the maximum interval of 24 line pipes (maximum distance 292.8 m). The aim in the Balticconnector project is to use zinc- and indium-activated aluminum bracelet anodes (Figure 3-3) electrically linked to the pipeline with copper cables. The cables will be protected against mechanical strain with a bitumen coating. According to preliminary assessments, there will be 278 anodes, each with a thickness of 50 mm.

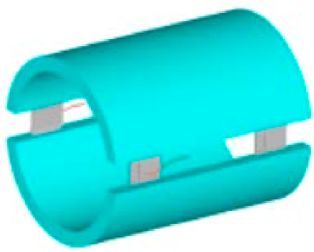


Figure 3-3. Example of an aluminum bracelet anode (*Ramboll 2014*).

The total consumption of material required for the offshore section of the Balticconnector pipeline is shown in the table below (Table 3-2).

Table 3-2. Total consumption of material used for the offshore pipeline section.

Part of pipeline	Material	Estimated volume (m3)	Weight (t)
Line pipes	carbon steel	1,631	12,803
Internal anti-corrosion coating	epoxy paint	7	11
External anti-corrosion coating	asphalt enamel or three-layer polyethylene	665 or 398	865 or 398
Concrete coating	concrete	9,544	32,450
Field joint insulation	polyethene	10	10
Field joint infill insulation	polyurethane foam	471	942
Anodes	AlZnIn mixture	8	22

3.4 Construction

3.4.1 Seabed intervention

Seabed intervention will be required to protect the pipeline and to rectify the pipeline free-spans. The types of seabed intervention that are likely to be applied in the Balticconnector project are:

- dredging;
- ploughing or jetting depending on soil conditions;
- blasting to remove bedrock;
- subsea rock installation underneath or on top of the pipeline.

Protection requirements

The pipeline will typically be installed on the seabed, but in some areas the pipeline will have to be protected by trenching and/or covering it with seabed sediment or rock cover (Figure 3-4). The main reasons for the pipeline protection requirements are maritime transport (dropped and dragged anchors), and ice gouging in coastal areas. The results of the Quantitative Risk Assessment report (*Ramboll 2014b*) show that protection will be required for 85% of the Balticconnector pipeline length.

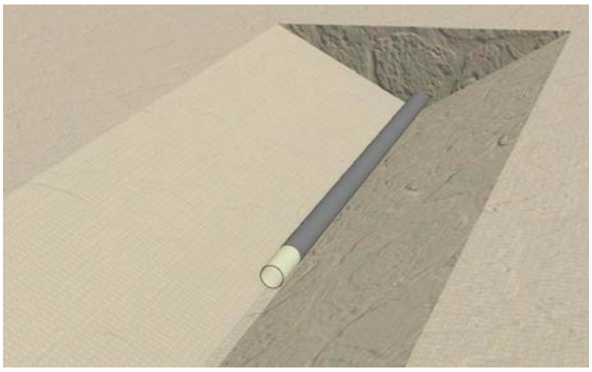


Figure 3-4. Cross-section of a trenched pipeline section (*Ramboll 2013*).

The pipeline will normally be trenched or covered with a layer of rock near the landfalls to ensure pipeline stability and, for sections close to the coast or shallows, to prevent ice scouring. According to preliminary plans, the pipeline section constructed in Ingå will be protected between KP 0 and KP 23. Rock cover will also be used at locations where existing pipelines and cables will be crossed.

Trenching

If trenched to a sufficient depth, the pipeline can obtain protection against anchor damage, grounding and sinking ships as well as ice scouring. The depth at which the pipeline should be trenched depends on the size of the vessels crossing the pipeline. Large vessels also have anchors with large fluke lengths which can penetrate deep into the seabed. Trenching can be used where the surrounding seabed does not consist of soft mud. If the pipeline needs protection on locations where the seabed consists of soft mud, the mud should be replaced with more stable material (sand or crushed stone) or a local re-routing should be considered, if possible.

On fairways the pipeline must be laid at a depth of 1-2 m, and outside fairways at a depth of 1 m (Figure 3-5).

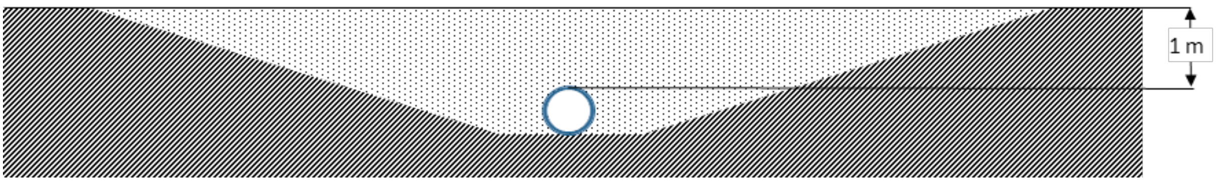


Figure 3-5. Pipeline trenching outside fairways (*Ramboll 2014a*).

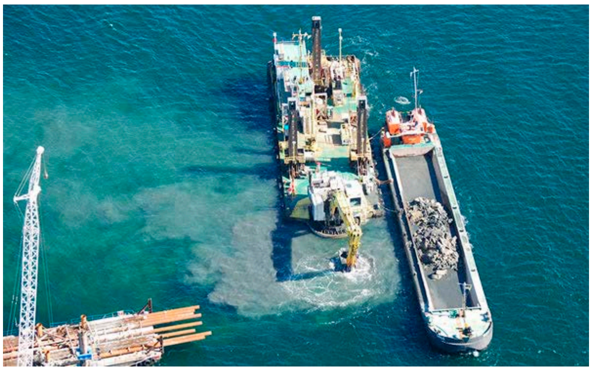


Figure3-6. Dredging techniques. Shown left is a remotely operated "spider" and right a dredging barge and loading vessel (*Ramboll 2014a*).

Trenching can be operated with a "spider" (remotely operated dredging vehicle) or, in shallow water areas, with a surface-based dredging arm (Figure 3-6).

Rock cover

In this context, rock dumping means that the pipeline remains on top of the seabed but is covered with a layer of rock. The rocks can then protect the pipeline against anchor damage and sinking ships. However, it is unlikely that the pipeline will be protected against ice scouring if only rock dumped (Figure 3-7), which is why the pipeline must be buried.

Installation of subsea rock will take place by using a rock dumping vessel and suspended fall pipe. The rock installation vessel (Figure 3-8) has a loading capacity of 24,000 tonnes. The vessel has a maximum rock installation speed of 2,000 tonnes per hour. However, a typical average rock installation speed which takes into consideration issues including transit times to and from quarry and between subsea structures is 150 tonnes per hour. Typical rock size used for pipeline protection is 22–125 mm. Larger rocks may for stability reasons be specifically required in shallow water.

Increased steel wall thickness or concrete coating

By increasing the wall thickness or the pipeline diameter, the force at which the pipeline can withstand is increased. Similarly, additional concrete coating can absorb larger impact forces.

The table below presents a summary of the protection measures required for the pipeline (Table 3-3). The rock volumes provided are conservative estimates and will be specified further once progress is made in the technical design of the project.

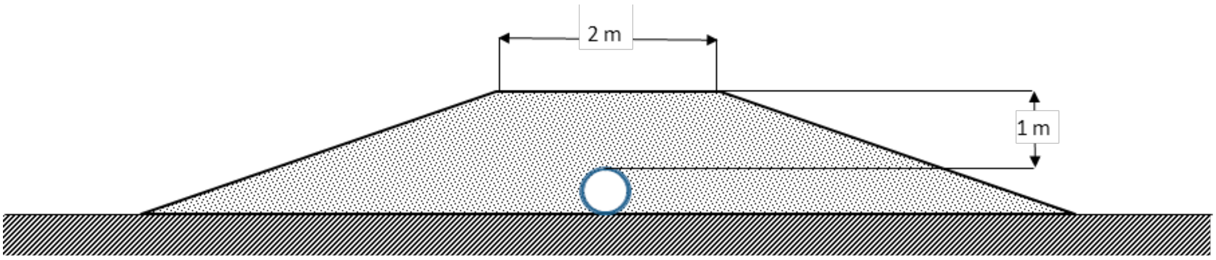


Figure 3-7. Pipeline with rock cover (*Ramboll 2014a*).

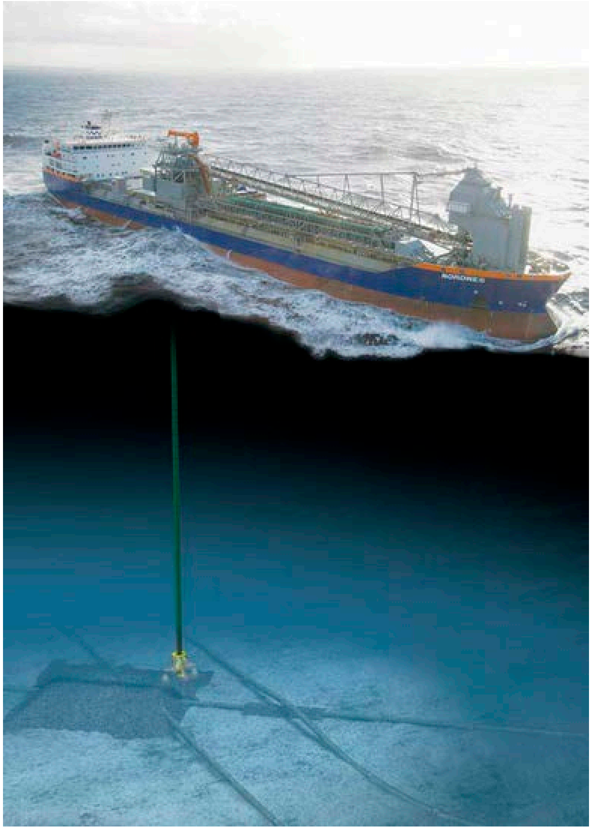


Figure 3-8. Subsea rock installation - accurate positioning by fall pipe (*Ramboll 2013*).

Table 3-3. A summary of the protection requirements.

KP	Hazards	Type of protection	Trenching length (m)	Estimated rock volume (m³)
0-23.0	Ice gouging	Trenching + 1.0 m rock cover	25,000	208,717
23.0-31.0	No significant hazards	-	0	1,313
31.0-37.0	Dragged anchor	1.0 m rock cover	0	54,448
37.0-39.0	Dragged/dropped anchor	Trenching + 2.0 m rock cover	2,000	45,445
39.0-44.0	Dragged anchor	1.0 m rock cover	0	45,373
44.0-46.0	Dragged/dropped anchor	Trenching + 2.0 m rock cover	2,000	45,445
46.0-59.0	Dragged anchor	1.0 m rock cover	0	117,971
59.0-62.0	No significant hazards	-	0	75
62.0-70.0	Dragged anchor	1.0 m rock cover	0	72,597
70.0-76.0	No significant hazards	-	0	0
76.0-81.4	Buried	Trenching + 1.0 - 2.0 m rock cover	5,400	49,003
Total			**34,400**	**640,387**

Freespan rectification

To ensure the pipeline will remain fully functional throughout its entire design life, it will be necessary to reduce the span length of the pipeline to prevent a local buckling failure of the pipeline. The following methods can be employed in pre-lay preparation of the seabed:

- rock-dumping span gap heights to ensure mid-span touchdown points (pre-lay and post-lay);
- dredging to create flat lay corridors (pre-lay);
- blasting of bedrock peaks (pre-lay).

According to preliminary calculations and plans, a significant amount of pre-lay preparation of the seabed will be required. The locations where pre-lay preparation will be required to reduce span length are shown in the table below (Table 3-4). The actual need for seabed intervention, including freespan rectification required, will be specified further once progress is made in the technical design of the project. It is, however, likely that the need for pre-lay preparation will be lower than presented here.

Installation of subsea rock

Installation of subsea rock is the traditional method of rectifying free spans using a rock dumping vessel and suspended fall pipe (Figure 3-8).

According to preliminary estimates, around 180,000 m³ of rock will be required before pipeline installation can occur. This amount is based on the following assumptions:

- All free spans requiring rectification are conservatively filled in their entirety along the entire length (whereas detailed design is likely to conclude only intermediary berms are required).
- Span fills are 20 m wide (lateral to the pipeline axis) to allow for +/- 10 m lay tolerance.
- Spans where both excavations and rock fill are required are conservatively calculated by halving the volume calculated by filling the gap beneath the span as calculated by the current bottom roughness analysis.

Table 3-4. Total volumes of subsea rock installation for freespan rectification based on preliminary calculations.

KP	Estimated rock volume (m³), pre-lay	Estimated rock volume (m³), post-lay
0-23.0	111,554	125 857
23.0-31.0	32 109	0
31.0-37.0	3 205	5 517
37.0-39.0	3 647	3 372
39.0-44.0	251	1 247
44.0-46.0	324	1 294
46.0-59.0	23 762	22 398.7
59.0-62.0	0	0
62.0-70.0	3 026	6 996
70.0-76.0	0	0
76.0-81.4	164	822
Total	**178 041**	**167 504**

Figure 3-9. Excavation techniques using hydraulic subsea equipment; T-series digger to the left, clay cutter to the right (*Ramboll 2014a*).

Excavation

Excavation can be performed either by dredging or blasting, depending on the soil conditions and the environment. For areas of bedrock, blasting will be necessary as conventional dredging may be slow and expensive. The removal of soil using jetting or clay cutters is known as dredging in this context (Figure 3-9).

Where dredging is not possible due to seabed condition, removal of bedrock peaks could be performed by using a traditional boring and blasting method, with special restrictions applied with regard to water-borne shockwaves and vibrations (Figure 3-10). Once the explosion has been triggered, loose rock will be moved alongside the pipeline.

Figure 3-10. Controlled subsea rock blasting (*Ramboll 2013*).

According to preliminary estimates, a total of 52 peaks will need to be excavated. The table below (Table 3-5) presents the preliminary volumes of seabed to be excavated by Kilometer Post. The volumes of seabed to be excavated will be specified further once progress is made with the project. The current estimates are conservative; the actual volumes are likely to be smaller than those presented here.

Table 3-5. Preliminary seabed intervention measures and volumes of seabed to be excavated to level the seabed during the construction of the Balticconnector pipeline.

KP	Intervention	Volume of material to be removed (m^3)
0-2.0	Blasting	85 000
3.5-5.0		
12.0-13.5		
14.0-15.3		
17.5-20.0		
20.1-23.6		
25.3-26.9		
45.4-48.3	Dredging/ploughing	47 000
48.8-51.5		
52.0-53.0		
55.3-57.1		
64.365.4		
79.481.4	Dredging	39 000

It is assumed that blastings in Estonian waters most probably will not be done. Still, in impact assessment blasting is considered as the worst-case scenario in some excavation sections also in Estonian waters.

The results of the EIA procedure and the detailed studies conducted after the procedure will be used to optimize the route of the Balticconnector pipeline in order to minimize the need for seabed intervention (Figure 3-11).

3.4.2 Infrastructure crossings

The pipeline will have to cross a number of subsea cables and the two Nord Stream pipelines. The crossing objects identified in marine surveys executed in 2006 and 2013 *(MMT 2006* and *MMT 2014)* are presented in (Figure 6-36). Unknown objects identified in the survey reports will be clarified in the more detailed design phase of the project. The majority of existing service lines are telecommunications cables or wires.

In addition to the Nord Stream gas pipelines in use, agreements will be entered into with the owners of any other cables and structures, in which the obligations and procedures for crossings will be determined. The owners of abandoned cables or relevant authorities will also be notified of the procedures relating to such cables.

Crossed cables will be buried in the seabed, but more detailed surveys in the detailed design phase of the project will determine the exact burial depth. A pre-lay rock berm may be placed to ensure a minimum 0.5 m vertical separation between the existing cable and the Balticconnector pipeline. The vertical separation should take into account the penetration of the pipeline into the rock berm and the settlement of the rock berm. Post-lay rock will also be installed after the laying of the Balticconnector pipeline to ensure the pipeline is protected from trawl hooking and pull-over, which may displace the pipeline from the pre-lay rock berm.

Abandoned cables are typically not removed. At crossing locations of abandoned cables there is also the option to cut the cable if approval is obtained from the cable owner. In most cases, however, it is simple, more cost-effective and less environmentally disruptive to lay the pipeline over the cable with the adequate vertical separation ensured.

The Nord Stream pipelines (Figure 6-36), separated by approximately 900 m at the point of crossing, will require two separate crossing designs. The pipelines have been installed exposed, so a height of approximately 2 m of pre-lay rock will be required to ensure a

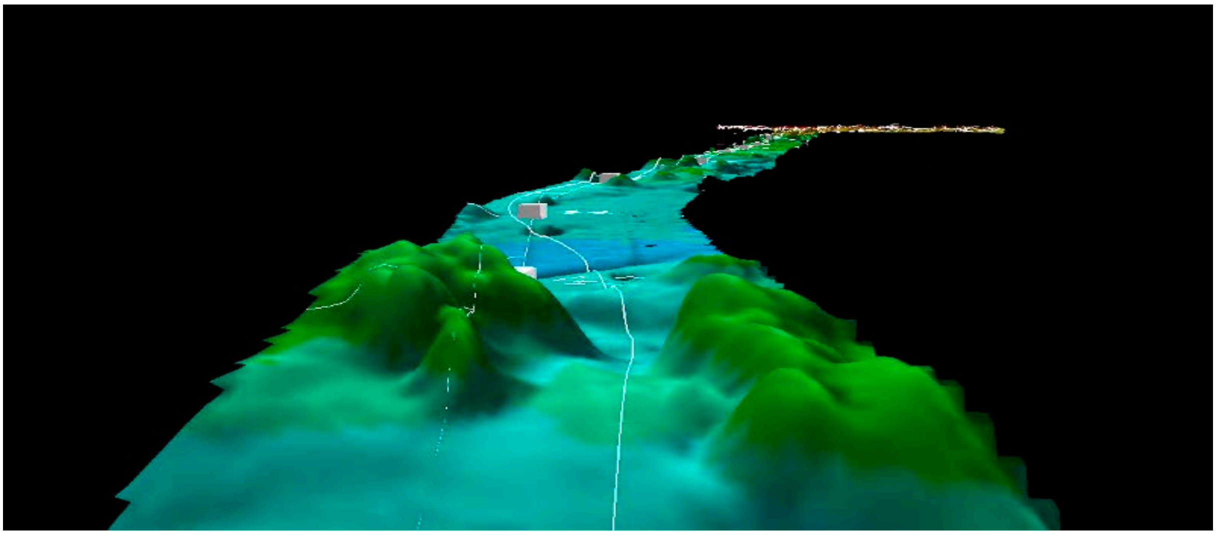


Figure 3–11. Gas pipeline route optimization on the seabed *(MMT 2006)*.

vertical separation of 0.5 m is maintained between the Balticconnector pipeline and the Nord Stream pipelines.

3.4.3 Munition removal

Munitions (unexploded ordnance, UXO) can be divided into conventional and chemical munitions. Munitions were dumped in the Baltic Sea during the First and Second World War and all the way until the 1960s. Unidentified items such as munitions and their remnants detected in the study corridor of the Balticconnector project will be examined and removed before laying the natural gas pipeline onto the seabed. Of the total of 48 man-made objects (including munitions, metal waste, barrels) detected in the study corridor, eight have been classified as probable munitions. Six of these are on the Estonian side and two on the Finnish side *(MMT 2006* and *MMT 2014)*.

In order to clear the munitions or their remnants, an ordinance clearance plan will be developed in cooperation with relevant national authorities. Gasum has conducted preliminary negotiations with the Finnish and Estonian Defence Forces, and it has been agreed that they will take part in the clearance work. The clearance plan will include clear risk assessment procedures for the technical performance of the work together with the mitigation measures to be taken to minimize impacts on marine flora and fauna. The clearance methods used will be safe, proven and similar to those previously employed to dispose of munitions in the Baltic Sea.

The disposal of unexploded ordnance (mines) will be performed in several steps, starting with an as-found survey, implementation of mitigation measures to minimize impact on marine life, placement of the demolition charge, demolition and an as-left survey.

Throughout the activities, the authorities will be kept informed of the status, and any marine traffic in the area will be warned to avoid the location.

3.4.4 Offshore pipe-laying

The offshore pipeline will be installed using either an anchored or dynamically positioned (DP) pipelaying vessel. Dynamic positioning is best suited for large water depths where the suspended pipe string is sufficiently flexible to absorb minor displacements at the surface without buckling. Dynamic positioning is also the best method in cases where there may be munitions outside the studied installation corridor, such as in the Gulf of Finland.

Depending on its type, the pipelaying vessel will be assisted by anchor tugboats, pipe supply vessels and various survey/monitoring vessels (Figure 3–12). For each anchor-positioned pipelaying vessel, 2–6 anchor-handling vessels will typically be required. These are typically quite large (total length around 100 m). Their stern and bow anchors will be dropped 1,000–2,000 m from the pipelaying vessel, while lateral anchors can be placed closer to the pipelaying vessel. Each individual anchor weighs around 25 tonnes. Whenever possible in the Balticconnector project, pipelaying and anchor-handling vessels that are as small as possible to minimize environmental impacts will be used in areas where it is not possible to use a dynamically positioned pipelaying vessel (coastal areas). The use of an anchored pipelaying vessel requires the detailed preparation of construction measures where the anchoring methods employed are determined precisely.

One service vessel will also be required for each pipelaying vessel. Dynamically positioned multi-purpose vessels will be used for anchor handling and maintenance functions (Figure 3–12).

Figure 3-12. Typical pipelaying vessels – a dynamically positioned pipelaying vessel (*Solitaire*, left) and anchored pipelaying vessel (*Castoro Sei*, right) (*Ramboll 2013*).

The coated line pipes will be transported by a supply vessel to the pipelaying vessel where they will be welded to form a pipe string and lowered onto the seabed. This process involves the following continuously repeated stages on board the pipelaying vessel:

- pipe welding;
- nondestructive testing (NDT) of welds;
- preparation of field joints;
- lowering the pipe onto the seabed.

Some major pipelaying vessels have double jointing facilities, whereby two 12.2 m line pipes can be welded together before they are transferred to the end of the pipe string (the firing line) and welded onto the pipeline. To save time, the welding will be carried out at a number of stations and, as the weld is completed, the pipeline goes into the tensioners. The field joint coating, however, will be carried out just before the stinger. After welding, the field joints will be inspected using nondestructive testing (NDT) to detect any damage or material defects. NDT will take place using automated ultrasound testing that enables the detection, measurement and recording of any defects. Before construction begins, the accepted range for welding results will be determined by the designated inspection authorities. After welding and testing, the field joints will be protected against corrosion (see chapter 3.3).

Once a weld is completed, the vessel will move forward a distance corresponding to the length of one or two individual line pipes. Following this move, another line pipe will be added to the pipeline as described above. As the pipelaying vessel moves forward, the pipe string is to be supported by a stinger extending 40–140 m behind the vessel. The purpose of the stinger is to support and control the pipe string (Figure 3-13). The lay rate is highly dependent upon pipe size and welding conditions, but under optimal conditions a daily production (working 24 hours) of 4–5 km is not unusual. The pipelay season may be expected to run during midsummer.

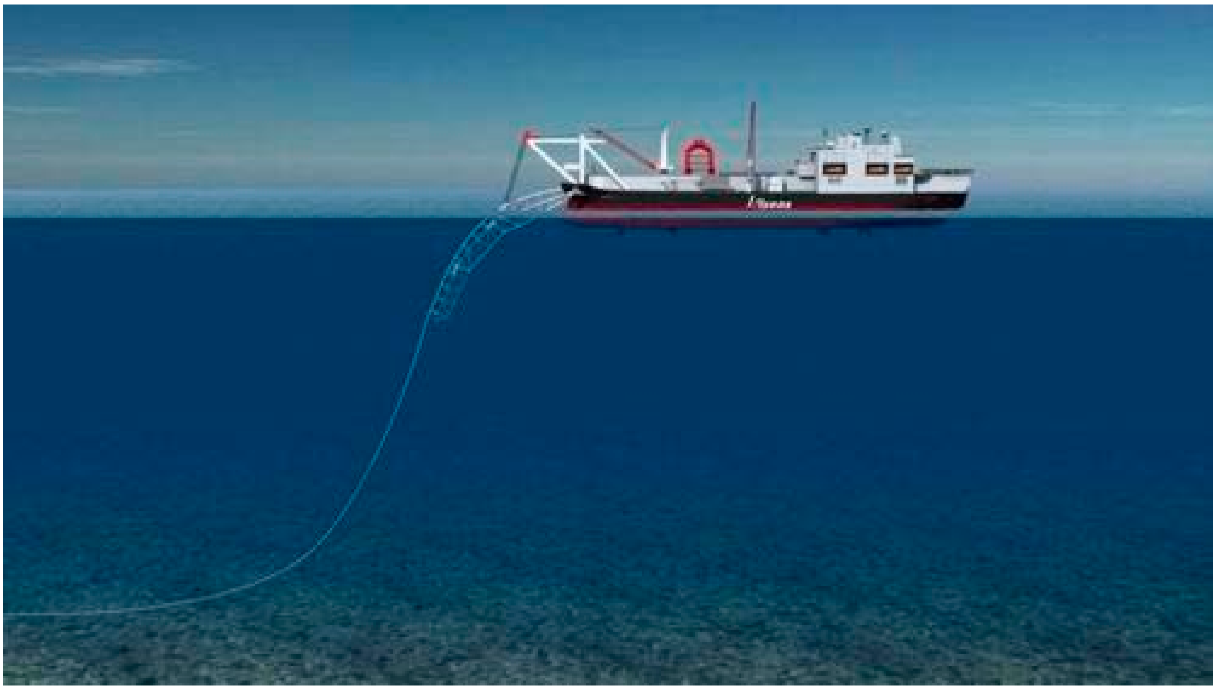


Figure 3-13. The S-lay method employed by a dynamically positioned pipelaying vessel (Allseas 2014).

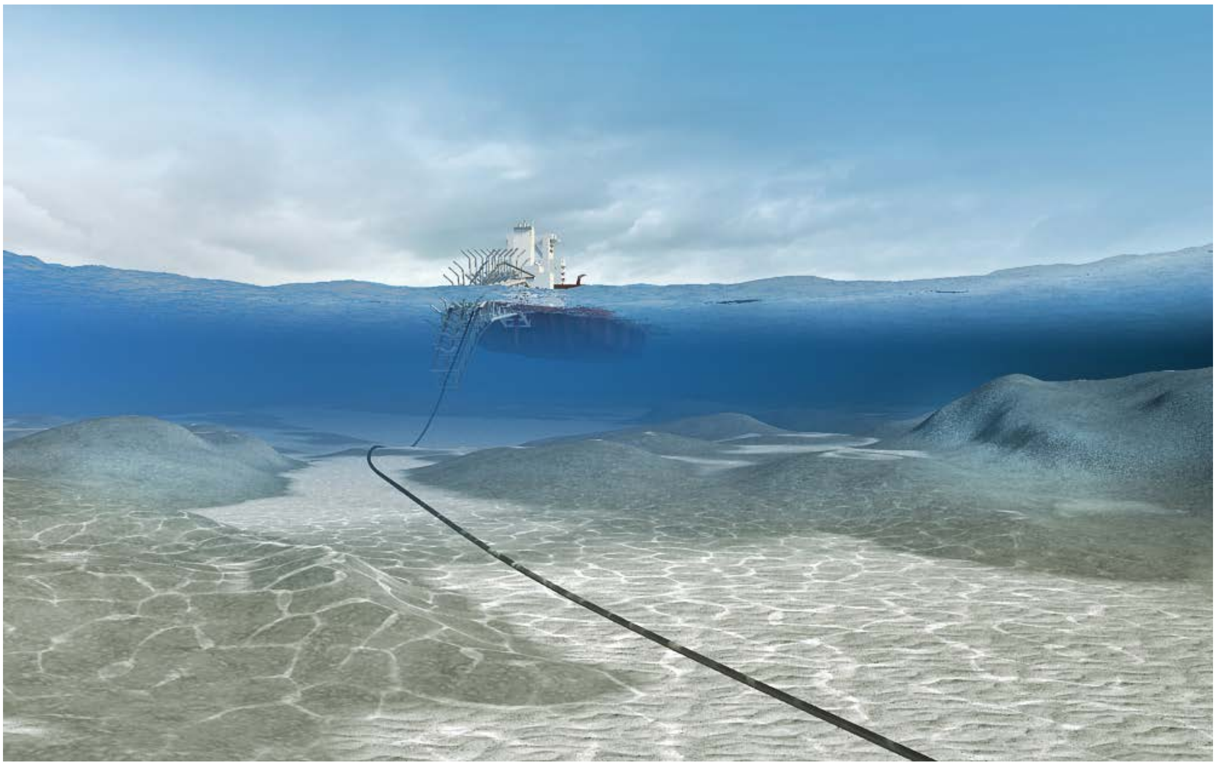


Figure 3-14. Visualization of pipelay installation of the Balticconnector pipeline between bedrock outcrops *(Ramboll 2014a).*

Pipelaying is weather dependent, and the tolerance depends upon the type and size of the pipelaying vessel and the supporting spread. At a certain sea state it becomes impossible to add more pipe to the string, which will then be kept under constant tension by the tensioners. Pipelaying will also have to be suspended if the weather prevents the vessels from docking at the pipelaying vessel to transfer pipe or other essential supplies or the tugboats from relocating the anchors (when dynamic positioning is not used). If the movements of the pipelaying vessel become so large that they endanger the integrity of the pipeline, the pipe will have to be temporarily abandoned. A laydown head with an attached cable will be welded onto the pipe, which will be lowered to the seabed. In case the pipelaying vessel is forced to abandon the site to seek shelter, the cable will be attached to a buoy for later retrieval. At the return of calm weather the pipe string will be winched aboard the pipelaying vessel, secured by the tensioners, the laydown head removed and pipelaying resumed. The above abandonment and recovery operations are fairly routine, but they may also be invoked in case of major mishaps (see Chapter 8).

Safety zones for pipeline installation vessels will be agreed with the maritime authorities in Finland and in Estonia. Based on a preliminary assessment, a safety zone of 1,500 m will be adequate for all installation vessels, including anchor-handling pipelaying vessels.

Except possibly for straight laying on an even seabed, the touchdown point of the pipeline will be continuously monitored by a remotely operated vehicle (ROV) deployed from a dedicated survey vessel.

3.4.5 Pipeline tie-in

Logistics dictate that at least one tie-in must be performed between the pipeline section laid from the Estonian landfall and the pipeline section laid from the Finnish landfall.

As a first step, buoyancy elements will be installed and the davit cables attached at locations determined by the lifting analysis. The offshore section will be lifted up, cut off at a length determined by the final metrology, an end plate welded on to prevent flooding and the pipe end lowered to the waterline. The near-shore section will then be lifted up and clamped in position, the laydown head removed and the pipe end prepared for welding. Finally, the offshore section will be lifted and clamped in position, the plate cut off and the pipe end prepared for welding, and the previously prepared pup piece lowered into place and welded in. The exposed steel will be provided with anti-corrosion coating and infill like any other offshore field joint.

Upon completion of the welding and protection, the clamps will be released and the pipe will be lowered onto the seabed in stages, the pipelaying vessel moving sideways to avoid overstressing of the pipe steel.

The operation is most feasibly carried out in rather shallow (depth less than 20 m) and sheltered waters close to one of the landfalls. The lay direction and construction sequence will be decided at the later stages of the project design.

3.4.6 Landfalls

Alternative construction methods for the landfalls of the Balticconnector pipeline are as follows:

- bottom pull;
- microtunneling;
- horizontal directional drilling (HDD).

The most common method of landfall construction is bottom pull, and this method would be the most feasible method for either of the Ingå landfall alternatives LF 1 and LF 2. In this rocky and sheltered Ingå archipelago no cofferdam would be required to protect the trench from sedimentation.

The bottom pull method is also suitable for the ALT EST 1 alternative at the Paldiski landfall with an open beach. For the ALT EST 2 alternative, an open trench through the limestone cliff is not appropriate, so microtunneling is the most feasible solution there.

Bottom pull

Bottom pull installation can be performed either to or from shore. The pipe will be pulled in a pre-dredged trench through the surf zone to a point above the high water mark. The depth of the trench must be sufficient to ensure that the pipeline is not exposed by seasonal or long-term variations of the seabed profile.

For a shore pull, a pulling station will be installed at the prepared onshore site, usually consisting of two linear winches connected to a hold-back anchor, which may be a sheet pile wall. The winch cables will be connected to the pull cable by means of a sheave arrangement, pulled in from the pipelaying vessel stationed offshore at the mouth of the trench. On the vessel the pull cable will be connected to a pull head, which will be welded onto the first pipe joint, and the pipeline will be pulled ashore as it is produced on the vessel. The figure below (Figure 3–15) shows the pull head emerging from the sea.

For offshore pull, a pipe-stringing site will be set up on shore, and the landfall pipe will be welded to form one string. The pipelaying vessel will be positioned at the mouth of the pre-dredged trench and, using the winches on the vessel, the already prepared pipe string will be pulled through the trench onto the vessel, from where pipelaying will be continued.

Microtunneling

Microtunneling is a process that uses a remotely controlled Microtunnel Boring Machine (MTBM) (Figure 3–16) to directly install concrete jacking pipes forming an underground microtunnel to accommodate the pipeline inside.

Microtunnel construction comprises the following activities:

- Launch shaft excavation: required to ensure correct alignment of the microtunnel. Heavy equipment, such as excavators and trucks, is used for this task.
- Microtunnel excavation: typical microtunnel equipment spread consists mainly of a hydraulic jacking system to jack the pipe, a closed loop slurry system to remove the excavated tunnel debris, a slurry cleaning

Figure 3-15. Pull head emerging from the sea at shore pull (*Ramboll 2014a*).

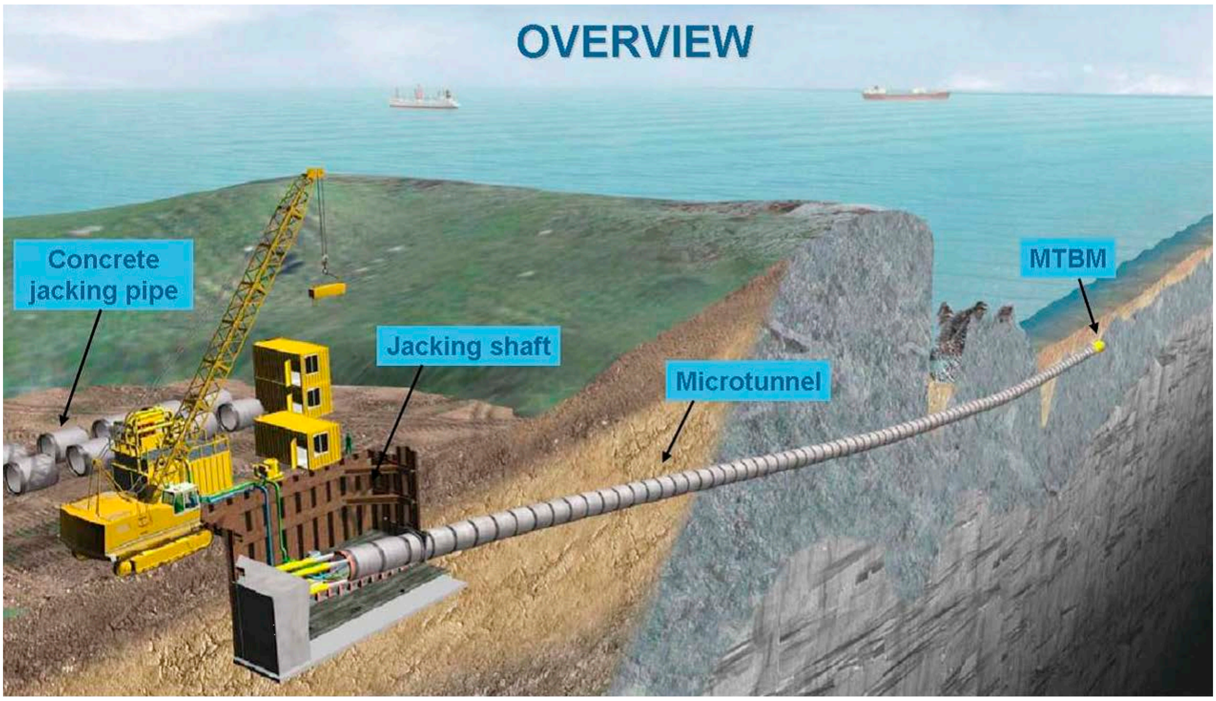


Figure 3-16. Landfall construction using the microtunneling method (*Ramboll 2014a*).

system to remove the debris from the slurry water, a crane to load and unload the concrete casings, and an electrical supply to power all of the above equipment.
- Pre-dredging and MTBM recovery: the recovery of the drilling head at the exit points requires dredging work.

The construction of the landfall microtunnel requires a temporary worksite of approximately 10,000 m². The maximum feasible length of the microtunnel is approximately 1,500 m.

Horizontal directional drilling (HDD)

Horizontal directional drilling (HDD) is an installation method in which the prefabricated pipe string is pulled through a hole in the ground made by a directed drill string.

A drill rig will be placed on shore and a pilot string inserted into the ground. The drill bit will be hydraulically powered by bentonite drilling mud fed through the pilot string. The bentonite mud will transport the soil away and fill the hole behind the drill head, preventing it from collapsing. The diameter of the cutting head is larger than that of the pilot string, which will be encased by a drill string, and additional lengths of pilot string and drill pipe will be added as the drill bit advances through the soil.

For landfall construction a pilot hole will be drilled to a pre-dredged trench at the marine exit point. A crane barge with supporting equipment to handle drill pipe and hole openers (reamers) will be positioned offshore. A number of hole opening passes will be carried out until the drilled hole is sufficiently large to accommodate the topical pipeline, and the crane barge will then be replaced by the pipelaying vessel.

As in the case of bottom pull, the pipeline produced on the pipelaying vessel can then be pulled into the drilled hole from the vessel (shore pull). Alternatively, the pipeline can be welded up on shore and pulled onto the pipelaying vessel (offshore pull). The latter method requires a sufficiently large area on shore for pipe stringing.

The drill can be made to exit within a few meters from a target point located several kilometers away. If the exit point is unacceptable, the pilot string will be withdrawn at a certain distance and the route corrected.

The success of the horizontal directional drilling method depends on soil conditions, fairly uniform clay being the most appropriate, but drilling through solid bedrock is also perfectly feasible. Horizontal directional drilling does not involve any activities between the entry point and the exit point and is therefore a preferred method for crossing heavily built-up or environmentally sensitive areas.

3.4.7 Construction of onshore pipeline sections and related functions

Work area

Both field and forest areas are suitable for natural gas pipeline construction. During construction, the installation of onshore pipeline sections will require a work area that is 28–32 m wide in forest areas and 33–37 m wide in field areas (Figure 3-17) and (Figure 3-18).

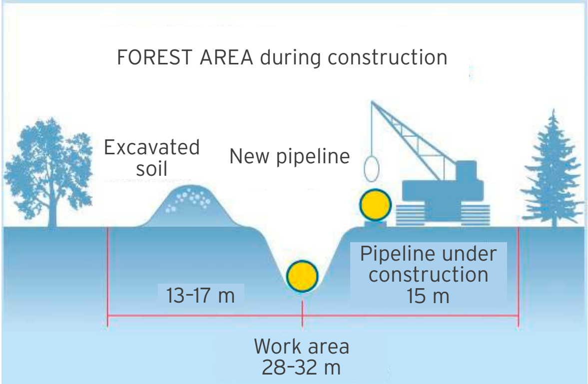


Figure 3-17. The work area required for onshore natural gas pipeline construction in forest sections (Gasum Oy).

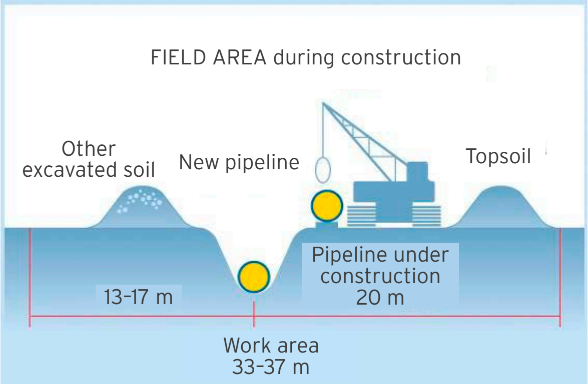


Figure 3-18. The work area required for onshore natural gas pipeline construction in field sections (*Gasum Oy*).

Pipeline construction

An installation road will be constructed for site traffic and pipeline installation next to the pipeline trench along the pipeline route (Figure 3-19). The line pipes will be transported to the site on public roads and site roads taken over for the purpose. Where necessary, new roads will be constructed to provide access to the natural gas pipeline area.

Figure 3–19. Example of a natural gas pipeline being laid (*Gasum Oy*).

To install the pipeline, a trench that is around 1.5–2 m deep will be prepared along the pipeline route. The excavated soil will be deposited next to the trench. In bedrock areas blasting will need to be used for trenching. The aim is to crush the rock blasted from the trench and use it for purposes such as installation road construction and post-lay trench backfilling.

The line pipes will be welded together to form the natural gas pipeline next to the trench or, in some cases, in the trench. All welds will be fully X-rayed by an external inspection body. Once the welds have been coated, the inspected natural gas pipeline will be placed in the finished trench using sidebooms or excavators.

The trench will be backfilled immediately after the completion of the pipelaying process, and the pipeline route will be marked with orange signposts. Signposted and reinforced transmission pipeline crossing points for forestry machinery will also be constructed in forest areas.

Pipeline crossings under roads and water bodies

Paved public roads are usually crossed by laying the natural gas pipeline in steel casing pipes drilled or jacked under the road. Public and private roads with low volumes of traffic (less than 500 vehicles a day) can be crossed by digging them open and building a temporary overpass or diversion.

The pipeline can be laid under small brooks, ditches or rivers using conventional digging or horizontal directional drilling. The prerequisite for horizontal drilling is that the ground is soft and free from rocks. Horizontal drilling is a feasible method if there are sections along the natural gas pipeline route due to which the use of conventional digging is prevented or not recommendable. If open excavation is used, the river will be dammed by constructing a soil dam on both sides for the period of construction.

Finishing and landscaping

The finishing work required will take place on the worksite once construction is completed. Deposition areas and any damage caused by construction in the area will be repaired and landscaped. The installation road will be removed unless agreed otherwise with the landowner. In field areas the installation road will be removed, subsurface drains repaired, field surface tilled and topsoil restored in areas where it had been removed.

Following construction and landscaping, the landowner can resume agriculture and forestry in the area. Trees may not, however, be planted in the pipeline protection zone (10 m on both side of natural gas pipeline, according to the validated thematic plan). In field areas the entire natural gas pipeline route can be used for farming.

3.4.8 Project logistics

The construction of the offshore pipeline will require onshore support operations that, in addition to steel pipe storage, will also serve as general storage facilities for consumables supporting vessel operations as well as premises for human resource management measures.

No separate concrete coating facility will be established for the Balticconnector project. The transport of steel line pipes protected against corrosion, anodes and materials used for concrete coating as well as the operations of the actual concrete coating facility are not included in the environmental impact assessment conducted. According to preliminary plans, the line pipes will be concrete-coated at an existing northern-European concrete-coating facility.

It is foreseen that at most one interim stockyard will be required for storage of coated pipes. The choice of locations for the stockyard will be based on detailed analyses to reduce onshore and offshore transportation requirements. The required storage area will be at most 10,000 m². From the interim stockyard the pipes will be transported directly to the pipelaying vessel. The logistics concept developed specifically for the project will comprise:

- transport of concrete-coated pipes to the interim stockyard;
- transport of concrete-coated pipes to the pipelaying vessels from the interim stockyard; and
- transport of rock from the quarry to the rock dumping sites.

If no interim stockyard is established, provisions and consumables for the offshore fleet can be supplied from the installation contractor's home base, and/or storage facilities provided at one of the landfall sites.

The logistics solution will be designed in a manner enabling the minimization of onshore and offshore transport distances as efficiently as possible.

Offshore pipe supply is required due to the limited cargo capacity of the pipelaying vessel. A pipe supply vessel will transport the pipes from the stockyard to the pipelaying vessels. The average transport capacity of a pipe supply vessel is around 240 line pipes at a time. The pipelaying vessels usually have a cargo capacity of around 6,500 line pipes. The supply and pipelaying vessels to be used in the project are described further in chapters 3.4.4 and 6.5.15.1.

Efforts will be made to source material for pre-lay and post-lay rock installation from a local quarry and load it at the harbor to a vessel that is able to place the rock very accurately on the seabed through the use of fall pipes. The transport of line pipes, pipelaying as well as rock transport and dumping onto the seabed are included in the environmental impact assessments conducted. The temporary storage of line pipes, the operations of the quarry, and the storage of rock before transport are not included in the impact assessments. The amounts and characteristics of rock to be dumped are discussed further in chapter 3.4.

3.5 Pre-commissioning and commissioning

Inspections will be carried out on the installed pipeline before the commissioning of the gas pipeline. These measures will aim to verify the integrity of the pipeline and compliance with the requirements set. The pre-commissioning spread is envisaged to be located at one of the landfalls, most probably in Estonia.

Pre-commissioning and commissioning will comprise the following activities:

- flooding and hydrostatic testing;
- gauging and cleaning;
- de-watering and drying;
- nitrogen purging and gas filling.

3.5.1 Flooding and hydrostatic testing

When all construction activities have been carried out, the final integrity of the installed pipeline will be documented by hydrostatic testing. In this, filtered seawater is pumped into the pipeline. The Balticconnector pipeline will be flooded immediately after pipelaying for stability reasons.

However, as any oxygen in the seawater will quickly be consumed by negligible rust formation, the treatment of the test water can probably be omitted. Furthermore, the risk of bacterial contamination is low if the residence time in the pipeline does not exceed 60 days.

To prevent internal corrosion of line pipe steel, the seawater may be treated with oxygen scavengers and/or biocides. The oxygen scavenger removes the oxygen which may fuel corrosion, and the biocide prevents the growth of anaerobic bacteria. A typical oxygen scavenger is sodium bisulfite ($NaHSO_3$), a dosage of 65 mg/l (ppm) being required for an oxygen concentration of 10 ppm. A common biocide is glutaraldehyde at an active concentration of 50–75 mg/l (ppm).

The hydrostatic testing will comprise a strength test as well as a leak test and will be carried out by pressurizing the water to the specified leak test pressure, which will be kept for the specified holding period typically of 24 hours. During the holding period the pressure will be closely monitored, and any pressure drop which cannot be ascribed to variations in atmospheric pressure, water levels or seawater temperature signals a leak, which must then be localized. To facilitate leak detection, the test water can be mixed with a powerful dye or a hydrocarbon tracer, which can be sensed by a 'sniffer' fish that is towed along the pipeline.

The use of dye can be minimized by mounting dye sticks at critical locations, such as tie-in points. Dye sticks or dye applied as a paint will be inserted by divers just prior to tie-in operations. The dye stick can be made of what is popularly labelled 'invisible' dye, which is fluorescent and visible only by a diver carrying an inspection tool.

Should a leak occur, it normally takes the form of a violent rupture, which is easily localized even if the pipeline has been trenched and backfilled. If a visual survey does not suffice to locate the failure, it is possible to launch a 'pinger' pig, which can be tracked acoustically until it stops at the rupture. Alternative means of location include the use of magnets or radioactive sources.

3.5.2 Gauging and cleaning

The pipeline will be cleaned and gauged internally by using pig trains. There are used to measure any dents in the line pipe wall that could induce failure in the long term or obstruct the passage of cleaning and batching pigs.

During and after water-filling the pipeline interior will be cleaned. The debris inside the pipeline will mostly be dust from construction, such as rust (iron oxide), welding powder, substances from the interior coating of the pipeline or concrete dust. The cleaning trains include both brush pigs and swabbing pigs, the latter removing any brushes that may have broken off. The pig trains are normally propelled by the treated seawater pumped in for the purpose of hydrotesting, but further cleaning by running brush and swabbing pigs in air may take place during and after de-watering.

The cleaning operation may also be facilitated by gel-plug technology. A gel is a plastic fluid with the capability to pick up loose and loosely adhering solids. The gel slug will be inserted into the pipeline, followed by an appropriately designed scraper pig. The train will consist of more scraper pigs collecting any gel slipping by the pig driving the gel. Gels can be produced with a range of viscosities, including solid gel pigs, capable of removing wax or paraffin deposits.

3.5.3 De-watering and drying

The activities of de-watering and drying are particularly important for gas pipelines, because any remaining water may react with the gas to form hydrocarbon hydrates, which can obstruct the flow and in particular the proper functioning of valves.

The de-watering operation will be planned with a view towards the disposal of the water, particularly if it is treated with corrosion inhibitors. Therefore for the natural gas pipeline a temporary outfall pipeline must be constructed so the water can be discharged at sea after the separation of solids in a settling pond. The water will be discharged through a diffuser head to ensure dilution to a concentration. However, flooding with untreated test water, or using oxygen scavenger only, is also possible.

Pipeline de-watering runs will be carried out using air-propelled pig trains during or after cleaning. A typical de-watering pig is shown in the figure below (Figure 3–20).

Figure 3–20. A typical de-watering pig *(Ramboll 2014a)*.

To dry the pipeline, the following methods can be used alone or in combination:

- methanol (or glycol) swabbing;
- hot air drying;
- vacuum drying.

In the swabbing method a batch of methanol or tri-ethylene glycol (TEG) is enclosed between pigs and propelled through the pipeline by compressed air. Residual water will be dissolved in the hygroscopic substance, leaving a film that is mostly methanol or glycol. An alternative procedure, which combines cleaning and drying in one operation, is gel pigging. Modern gel-forming agents can produce gels from an array of liquid components. By incorporating gels based on hygroscopic fluids, such as methanol, into the cleaning train, the water is removed along with the debris.

Hot air drying utilizes the ability of hot air to contain a large amount of water as vapor, while vacuum drying relies upon the lowering of the boiling point of water at low pressures. For the Balticconnector pipeline the vacuum pumps will have to work for several days to decrease the pipeline pressure below a few millibars. To save time, vacuum drying is often used as the last step after most of the water has been removed by swabbing or gel pigging.

3.5.4 Nitrogen purging and gas filling

To prevent any internal corrosion between pre-commissioning and operation, the pipeline can be filled with a non-corrosive gas, such as nitrogen. A typical nitrogen purity would be 95% (i.e. 95% N_2, 5% atmospheric gases). However, if any free water is present, the nitrogen should constitute more than 99.98% of the gas.

For a vacuum-dried gas pipeline the nitrogen can simply be let in, while in other cases the air in the pipeline will be displaced by nitrogen in a process known as purging. Liquid nitrogen will be vaporized through heat exchangers and injected into the pipeline. To guarantee a low level of oxygen, the amount of injected nitrogen should be approximately twice the volume of the pipeline.

However, if the pipeline is completely clean and dry and is taken into operation within a reasonable time span (one year) after pre-commissioning, there is no need to fill the pipe with nitrogen or any other form of non-corrosive gas.

Gas filling of the pipeline will take place during the commissioning of the pipeline system, including the onshore sections and the compressor station.

3.6 In-use operations and control

The natural gas pipeline will be controlled and monitored from the central control room located in Finland and Estonia and staffed around the clock. Central control room staff monitor gas pipeline and compressor station process data and control the processes whenever necessary.

Gasum is obliged to maintain the appropriate working order of the natural gas pipelines. This means periodic inspections as well as maintenance and servicing work on the pipeline. The pipeline will be subjected to regular internal and external inspections throughout its operational life. External inspections include inspections of pipeline location and condition as well as corrosion protection. Internal inspections will be carried out using pigs. These will be driven through the pipeline along the gas flow and are used to gauge pipeline characteristics. The pigs have high-resolution sensors that detect the slightest of irregularities in the pipeline.

3.7 Schedule of the project

The table below (Table 3-6) outlines the preliminary schedule of the Balticconnector project. According to the preliminary plans, the project design phase will be implemented in 2016–2018, the construction phase 20192020 and commissioning will take place in 2021. The schedule of the project's EIA procedure is presented in Chapter 4.3.

Table 3-6. Outline of the preliminary project schedule.

3.8 Relationship of the project with other relevant strategies and planning documents

3.8.1 Conformity with European Union and other international energy and environmental objectives

International environmental protection objectives are similar to the objectives of Estonia and the European Union – the aim is a high level of environmental protection. As a Member State, the objectives of environmental protection in Estonia have been aligned with the environmental protection objectives of the European Union and also with the obligations and recommendations arising from various EU directives and international agreements.

The treaty establishing the European Community does not directly contain provisions regulating the field of energy. The principles and policies of the treaty establishing the European Community are used as the basis for achieving the Community objectives in determining actions in energy sector. Actions in the energy sector must also take into consideration the environmental policy objectives of the Community and consumer protection requirements and also vice versa.

The strategic objectives of the energy sector are the following:

- guaranteeing the security of energy supply in circumstances of increasing dependence on supply from outside the Community;
- improvement of the competitiveness of European industry through increased integration of energy markets;
- implementation of an energy policy in accordance with the principles of sustainable development through more rational energy use and wider use of renewable sources of energy;
- development of scientific research and technologies in the field.

The very high level of dependence of the European Community on sources of liquid fuel and a gas supply outside the Community poses a risk to the economies of Member States. In this respect, it is considered necessary to implement measures that would guarantee Member States with an uninterrupted supply of energy even in the event of disruptions of supply from outside the Community.

In April 2000, the action plan for energy efficiency of the European Union was adopted. The purpose of the action plan is to reduce the consumption of energy, protect the environment, ensure security of supply and a sustainable energy policy by improving energy efficiency. Energy efficiency means development of a conduct, working method or production technology that is of lower energy intensity.

Below is a selection of various European Union directives rthat most directly relate to the project activities:

Directive 2000/60/EC of the European Parliament and of the Council, establishing a framework for the Community action in the field of water policy, October 23, 2000 – the Directive establishes a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater, which prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands. The objective is to promote sustainable water use and an incremental reduction of emissions with the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.

Directive 2002/49/EC of the European Parliament and of the Council, relating to the assessment and management of environmental noise, June 25, 2002 – The Directive aims to define a common approach intended to avoid, prevent or reduce on a prioritized basis the harmful effects, including annoyance, due to the exposure to environmental noise. It furthermore aims at providing a basis for developing measures to reduce noise.

Directive 92/43/EEC of the Council of Europe, on the conservation of natural habitats and of wild fauna and flora, May 21, 1992 – The aim of the Directive is to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies. Measures taken pursuant to this Directive designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora take account of economic, social and cultural requirements and regional and local characteristics.

VASAB 2010 and the European Union's Biodiversity Strategy to 2020 are also related to the project being assessed.

VASAB 2010 international planning cooperation documents

Visions and Strategies around the Baltic 2010 (VASAB 2010) is a multi-lateral cooperation forum of the ten countries around the Baltic Sea Region. The international strategic planning document, VASAB Long-Term Perspective for the Territorial Development of the Baltic Sea Region 2030 (2009), defines the long-term perspective for development of the Baltic Sea region to the year 2030. The main emphasis is on cooperation between cities, improvement in relationships between urban and rural regions and the increase in availability of the Baltic Sea Region globally. According to the key idea of VASAB 2010, cities of the Baltic Sea Region must establish an internationally competitive network where different levels perform different roles: an important element of spatial structure is connection channels that must ensure efficient and sustainable connection between the cities. The document also states that the northern and eastern shore must be connected to gas supply sourced from North Sea using relevant ports and new pipelines. The objective that has been adopted is to establish common electricity and gas supply rings in order to improve the sustainability and stability of the energy market in the Baltic Sea Region. As part of the project "Agenda 21 – Energy", a scenario for sustainable development of energy in the Baltic Sea Region has been developed.

The objective of the project is directly linked to the long-term development perspective strategy of VASAB 2030.

European Union's Biodiversity Strategy to 2020

Within the framework of the biodiversity policy of the European Union, in 2011 it adopted the European Union's Biodiversity Strategy to 2020 which aims to halt the loss of biodiversity and ecosystem services in the EU and, to the extent possible, reverse the continuing trends of biodiversity loss and ecosystem degradation. According to the European Union's Biodiversity Strategy to 2020, the plan requires fast-paced action in order to ensure that by 2020 functioning ecosystems are preserved which are supporting the diversity of wildlife and that would also ensure welfare of the people and reduce poverty. The vision for 2050 is Living in Harmony with Nature.

3.8.2 Conformity of the project with objectives of Estonian environmental protection

The objectives of environmental protection in Estonia have been established in two major strategic documents: national strategy "Sustainable Estonia 21" and "Estonian Environmental Strategy 2030".

Estonian National Strategy on Sustainable Development "Sustainable Estonia 21" is a strategy of Estonia for developing the Estonian state and society until 2030 with the aim of integrating the success requirements arising from global competition with the principles of sustainable development and preservation of the traditional values of Estonia. According to "Sustainable Estonia 21", the realisation of the welfare aspirations of one generation should not impair the possibilities of future generations. The objective relating to environmental protection is the maintenance of ecological balance in the nature of Estonia, which is a central precondition for its sustainability. It is also a contribution to global development, following the principle that requires a balance both in matter cycles and in flows of energy at all levels of the living environment.

The goal of ecological balance is divided into three main components:

- use of natural resources in ways and quantities that ensure ecological balance;
- reduction of pollution;
- preservation of biological diversity and natural areas.

"Estonian Environmental Strategy 2030"

The Environmental Strategy 2030 is a strategy for developing the sphere of the environment which builds upon the principles of the National Strategy on Sustainable Development "Sustainable Estonia 21" and serves as the basis for the preparation and revision of all sector-specific development plans within the sphere of the environment. The Estonian Environmental Strategy 2030 aims at defining long-term development trends for maintaining a good status of the natural environment, while keeping in mind the links between the sphere of the environment and economic and social spheres and their impact on the natural environment and people. Objectives established by the Estonian Environmental Strategy are divided into four categories:

- sustainable use of natural resources and reduction of waste generation;
- preservation of landscapes and biological diversity;
- climate change mitigation and quality of ambient air;
- environment, health and quality of life.

The objective of the project is to establish a method of alternative gas supply which is incremental to the gas imported from Russia, and to increase Estonia's supply security of gas. The planned action is not directly related to the implementation of environmental protection-related objectives of Estonian national strategies, and is not linked with the topics addressed by the strategies in detail. However, nor is it at odds with the aforementioned strategies.

3.8.3 Relationship of the assessed project with strategic planning documents

This chapter aims to provide an overview of the relationship of the assessed project and its conformity with the (environmental) objectives and requirements of national strategic planning documents.

3.8.3.1 National spatial plan "Estonia 2030+"

On August 30, 2012, the Estonian Government under Order No 368 adopted the national spatial plan "Estonia 2030+". The purpose of the plan is to obtain a spatial basis, shaped by the specific character of the environment, for shaping settlement, mobility, national engineering infrastructure and regional development.

One of the primary objectives in the energy sector is to expand the options for supplying Estonia with energy by creating external connections with energy networks in the Baltic Sea Region. Furthermore, it is necessary to avoid any unwanted impact on the climate, achieve a higher share for renewable energy in the energy supply, ensure the implementation of energy-efficient measures, and decrease the environmental impact of energy production.

An extensive integration of the energy networks of Estonia and the Baltic Sea Region is important in terms of security of supply and energy security, as well as from the standpoint of supplying energy to the residents of Estonia at the lowest possible price. According to the national planning policy statement, worth considering is the connection of the natural-gas networks of Estonia and Finland via, for example, a transnational pipeline originating in Paldiski. The valid national spatial plan "Estonia 2030+" suggests the need start preparations for the construction of a subsea gas pipeline from Finland to Estonia – this initiative is encouraged by the interest of Finland in the underground gas deposits of Latvia. If a future gas pipeline from the North Sea is constructed from Sweden to Finland, the pipeline between Estonia and Finland would connect the Baltic States to a Baltic Sea gas ring. Estonia would then be guaranteed an alternative gas supply compared to its current sole dependence on Russian supply.

In summary, it is prudent to improve the spatial connection of Estonia to Europe by connecting Estonia to the combined electricity and gas supply systems of the Baltic Sea Region. **The project being developed would help implement this objective, and as such be consistent with the strategic objectives of the national spatial plan.**

3.8.3.2 Estonia's National Development Plan of the Energy Sector Until 2020

The aim of the National Development Plan of the Energy Sector of Estonia is to combine the specific development plans of the sector and to set the general objectives of energy policy until 2020.

The mission of the Estonian energy sector is to ensure a continuous, efficient, sustainable energy supply in Estonia at a justified price and sustainable energy consumption.

The overview regarding the current situation in the natural gas market *(Chapter 1.4.2.2 Natural gas market)* states that in order to increase the security of gas supply, the possibilities for the construction of new cross-border connections, the liquid and liquefied gas terminals must be examined. Estonia has connections only with Russia and Latvia and is therefore in a similar situation to the other Baltic States and Finland in that there are no connections to other EU Member States and the only gas supplier is Russia. The objective of the regional development as stated in the development plan (*Chapter 1.9*) is that upon the development of regional energy markets, Estonia cooperates actively with its neighboring states. Closer cooperation takes place with the other Baltic States and the Nordic countries.

The National Development Plan of the Energy Sector of Estonia states the most important activities for the implementation of the objectives are the construction of new natural gas infrastructures from the Baltic States to other EU Member States, including the construction of new liquid gas and/or liquefied natural gas infrastructures. **The project directly helps to increase security of supply of gas to Estonia.**

3.8.3.3 Harju County Development Strategy for 2025

One of the objectives of the Harju County Development Strategy for 2025 is balanced and coherent spatial planning in cooperation between state, county and local governments.

The development strategy states that Harju County, with Tallinn as its center, is developing at a fast pace and at such a quick rate of development long-term planning and a balanced spatial pattern are very important. The business trends in Harju County are that companies with operations that require fast (also international) logistics have moved to or established themselves in the surrounding area of Tallinn (also evidenced by the high occupancy rate of industrial parks in the surrounding area of Tallinn).

The objective of this project, to establish a method of alternative gas supply which is incremental to the gas imported from Russia and to increase Estonia's supply security of gas, is not directly related to implementation of the development strategy of Harju County and is not linked to the topics addressed in further detail in the strategies.

3.8.3.4 Harju County Plan

Harju County Plan seeks to interrelate the overall physical and economic development strategy and concepts together with the principles of long-term sustainable development, to balance national and local interest and thereby influence human settlement patterns and determine the location of valuable arable land, landscapes, railways, utility network routes, ports, airports, recreational areas and other sites.

Among the requirements for development specified in the County Plan, the situation of the city of Paldiski is best described by the following requirements for development:

- human potential aspiring to move to the surrounding area of the capital;
- opportunity to use the infrastructure of the capital;
- existence of available and suitable areas, above all for the construction and expansion of industry and ports.

The objective of this project, to establish a method of alternative gas supply which is incremental to the gas imported from Russia and to increase Estonia's supply security of gas, is not directly related to the implementation of the objectives provided in the Harju County Plan. It is nevertheless important to mention that a new county plan is presently being formulated. As the county plan is being drafted, it is planned to bring the county plan into conformity with the national planning policy statement already in force and which already directly provides for a gas pipeline.

3.8.3.5 The thematic plan of Harju County titled "Environmental Conditions Affecting Habitation and Land Use"

The thematic plan of Harju County was adopted under Order No 365 of the County Governor of Harju on February 11, 2003. An overview of the link to the county thematic plan is provided in Chapter 5.2.8.7.

3.8.3.6 The thematic plan of Harju County titled "Cycle and Pedestrian Tracks of Harju County"

The thematic plan of the Harju County plan titled "Cycle and Pedestrian Tracks of Harju County" (adopted by Order No 1-1/697-k on April 24, 2012 by the County Governor of Harju) was the basis for the reservation of a potential cycle and pedestrian track corridor in the immediate vicinity of the point of landfall of ALT EST 1 by the Vana Tallinn highway.

3.8.3.7 Development plan of the city of Paldiski 2025

The vision of the development plan of the city of Paldiski to 2025 is that Paldiski has an important location in terms of logistics, a diverse economy, green environment, social security, is a multi-cultural port city with a unique history that is a favorable environment for living in and for tourists to visit. An important location in terms of logistics means that Paldiski is located at the intersection of the sea, highway and railways. Paldiski has important strengths for economic development, including the fact that the liquefied natural gas terminal is situated in the city.

In addition to the development of business, Paldiski can develop residential construction in new communities of single family houses on the Pakri Peninsula, supported by its position as a satellite city of Tallinn and an attractive landscape.

Therefore, the implementation of the project that is being assessed supports the objectives established by the development plan of the city of Paldiski.

3.8.3.8 Comprehensive plan of the city of Paldiski to 2015

According to the comprehensive plan of the city of Paldiski, the landfall of ALT EST 1, together with the onshore pipeline, is located on land designated by the comprehensive plan of the city of Paldiski for landscaping and protective vegetation (HL), which is a buffer zone for the Tallinn-Paldiski highway (T-8). An extract of the comprehensive plan of the city of Paldiski and a description of the settlement in the Kersalu region is provided in section 5.2.9.1.

According to the comprehensive plan of the city of Paldiski, ALT EST 2 will be located in the Neeme region, which is designated as a recreation area (P – recreation and leisure area) by the comprehensive plan adopted in 2004. However, the comprehensive plan was subsequently amended by a thematic plan and detailed plan adopted thereafter – the Paldiski LNG terminal is planned on a part of the designated recreation area (the thematic plan was adopted by decision No 5 of the City Council of Paldiski on September 27, 2012; the detailed plan for onshore LNG area was adopted by decision No 21 of the City Council of Paldiski on May 22, 2014). An extract of the comprehensive plan of the city of Paldiski and a more detailed description of the settlement is provided in section 5.2.9.1.

The ALT EST 1 point of landfall and the onshore part of the gas pipeline within the protective vegetation zone in the sanitary protection zone of the Tallinn-Paldiski highway are not at odds with the solution of the comprehensive plan. The thematic plan (and subsequent detailed plan) of the LNG terminal adjacent to the ALT EST 2 point of landfall has amended the solution of the comprehensive plan of the city of Paldiski with respect to the designated recreation area. According to the comprehensive plan amended by the detailed plan, the comprehensive plan supports the location of both of the routes through the amendments that entered into force.

4 THE EIA PROCEDURE FOR THE PROJECT

4.1 The international EIA procedure

The offshore pipeline would enable the exchange of natural gas between Finland and Estonia. Because the Balticconnector project has an international dimension, there are two primary international procedures to be followed:

- The Espoo Convention (UNECE Convention on Environmental Impact Assessment in a Transboundary Context);
- The Bilateral Agreement on EIA between Finland and Estonia (Agreement between Finland and Estonia on Environmental Impact Assessment in a Transboundary Context).

The need for assessing the environmental impacts of the project with regard to Estonia is based on the EIA and Environmental Management System Act (*RT I 2005, 15, 87*) In Finland, the need for the assessment is based on the Finnish Act on Environmental Impact Assessment Procedure (468/1994).

4.1.1 The Espoo Convention

The United Nations Economic Commission for Europe (UNECE) Convention on Environmental Impact Assessment in a Trans-boundary Context (Espoo Convention, 67/1997) entered into force in 1997. Finland and Estonia have both signed and ratified the Convention.

The Balticconnector natural gas pipeline is subject to an obligatory EIA procedure by virtue of Appendix I, section 8 (Large-diameter oil and gas pipelines) of the Espoo Convention. The parties to the Espoo Convention have the right to participate in the EIA procedure of the project. The Ministries of the Environment of Estonia and Finland, which are the competent authorities of the procedure and responsible for the practical arrangements of conducting the international consultation, have notified Finland, Estonia, Russia, Latvia and Lithuania of the project. As a result of the notification phase, Finland, Estonia and Russia will participate, while Latvia wanted information about the assessment results. An international consultation procedure pursuant to the Espoo Convention will be performed in connection with the EIA procedure (RT II 2000, 28, 169).

4.1.2 Bilateral agreement between Estonia and Finland

A bilateral agreement between the Government of the Republic of Finland and the Government of the Republic of Estonia on Environmental Impact Assessment in a Transboundary Context entered into force on June 6, 2002. The bilateral agreement specifies the principles for applying the Espoo Convention. According to Appendix I, section 8 – Large-diameter oil and gas pipelines. Underwater pipelines in the Baltic Sea – the Balticconnector project is categorized as a mandatory EIA project if the proposed activity may cause significant adverse transboundary environmental impacts (*Ramboll 2014c*).

Based on article 5 of the EIA Agreement, Estonia and Finland have established a Joint Commission on EIA in a Transboundary Context. Members of the Commission consist of environmental officials from Finland and Estonia. The Commission is organized as a sub-group under the Finnish-Estonian Working Group, which was established in 1991 (*Ramboll 2014c*).

Under Article 14, the competent authorities of the Parties are entitled to agree to carry out a joint environmental impact assessment (Joint EIA) within the framework of their national legislation. EIA reports have been conducted simultaneously and in cooperation between the Estonian and Finnish EIA experts (*Ramboll 2014c*).

Taking account the nature of the Balticconnector project (pipeline between two countries), both countries will act as Party of Origin and Affected Party. That means both countries are required to notify other countries about the EIA procedure, which will be conducted according to the national requirements. General authority cooperation based on the bilateral EIA agreement is shown in the figure (Figure 3-1) (*Ramboll 2014c*).

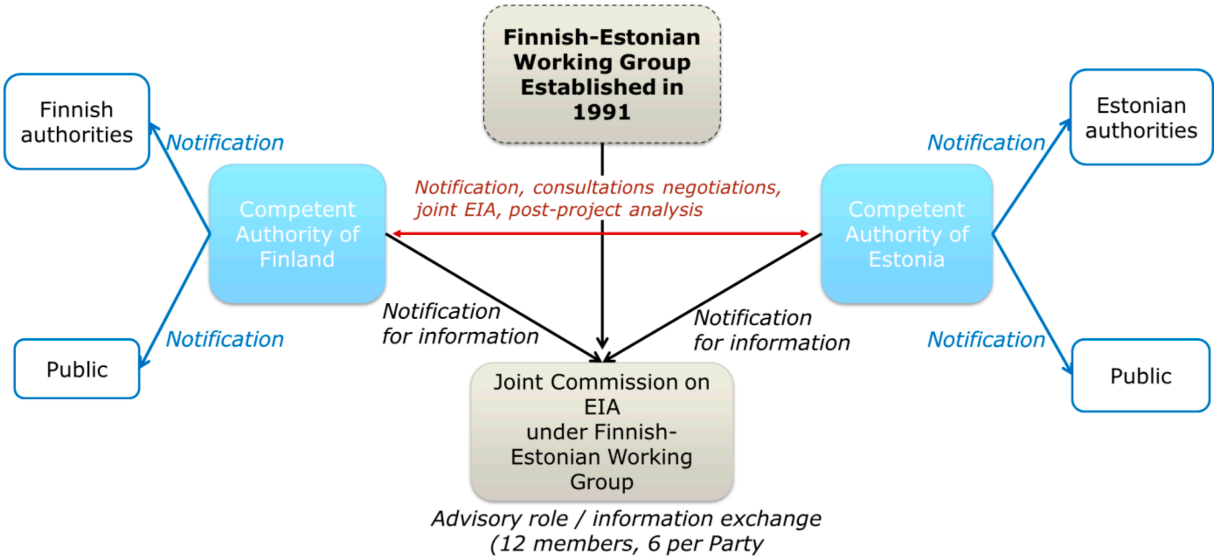


Figure 3-1. Authority cooperation under the EIA agreement *(Ramboll 2013)*.

4.2 The EIA procedure in Estonia

4.2.1 Applying the EIA procedure in Estonia

Under the EIA and Environmental Management System Act in Estonia, the objective of environmental impact assessment (EIA) is:

1. to make a proposal regarding the choice of the most feasible solution for the proposed activities based on the results of the EIA. This makes it possible to prevent or reduce damage to the state of environment and to promote sustainable development;
2. to provide information to the permitting authority on the environmental impacts of the proposed activity and feasible alternatives, and the possibilities to prevent or minimize negative environmental impacts;
3. to allow the results of the EIA to be taken into account in the proceedings for issuing a development consent.

Environmental impacts shall be assessed:

1. upon application for or application for amendment of a development consent, if the proposed activity, on which the application is based potentially results in significant environmental impact;
2. if activities are proposed which either alone, or in conjunction with other activities, may have the potential to significantly affect a Natura 2000 site.

Environmental impact is significant if it may potentially exceed the environmental capacity of a site, as irreversible changes to the environment endanger human health and well-being, the environment, cultural heritage or property (*Ramboll 2014c*).

An EIA is mandatory for following activities which may cause significant environmental impact:

- for the construction of high-pressure pipelines for the transport of natural gas, or main pipelines for the transport of petroleum or chemical products or other liquids, with a diameter of more than 800 mm and a length of more than 40 km;
- for marine dredging, starting from the soil volume of 10,000 m³, sinking of solid substances into the seabed, starting from the soil volume of 10 000 cubic meters.

The diameter of the Balticconnector natural gas pipeline is less than 800 mm. However, the marine dredging and soil sinking amounts are exceeding 10 000 cubic metres, which makes EIA procedure as compulsory.

Under the EIA Act, an EIA must be carried out by an expert holding an EIA license (granted by the Minister of the Environment).

4.2.2 Initiation of the EIA procedure

In order to initiate the EIA procedure in Estonia, the developer submits a permit application to the permitting authority, which makes a decision about the initiation of the EIA procedure.

After consulting with the Ministry of the Environment (MoE) and the Ministry of Economic Affairs and Communications (MEAC), Gasum Oy submitted superficies license application to burden public water body and installation of natural gas pipeline to seabed to the MEAC on May 14, 2013. After reviewing permit application and coordination with government authorities MEAC decided to initiate the procedure of application of superficies license.

Based on Estonian Government order 12.12.2013 No 555 (RT III, 17.12.2013, 6) on initiation of superficies license proceedings, it was decided to initiate EIA procedure. MEAC informed publicity about initiation of EIA procedure on December 20, 2013 and the procedure of application of superficies licence was suspended according to EIA act (*EIA act § 11 clause 11*) until approving the EIA report.

After initiation of the EIA, a two-phase EIA procedure follows (Figure 4-2).

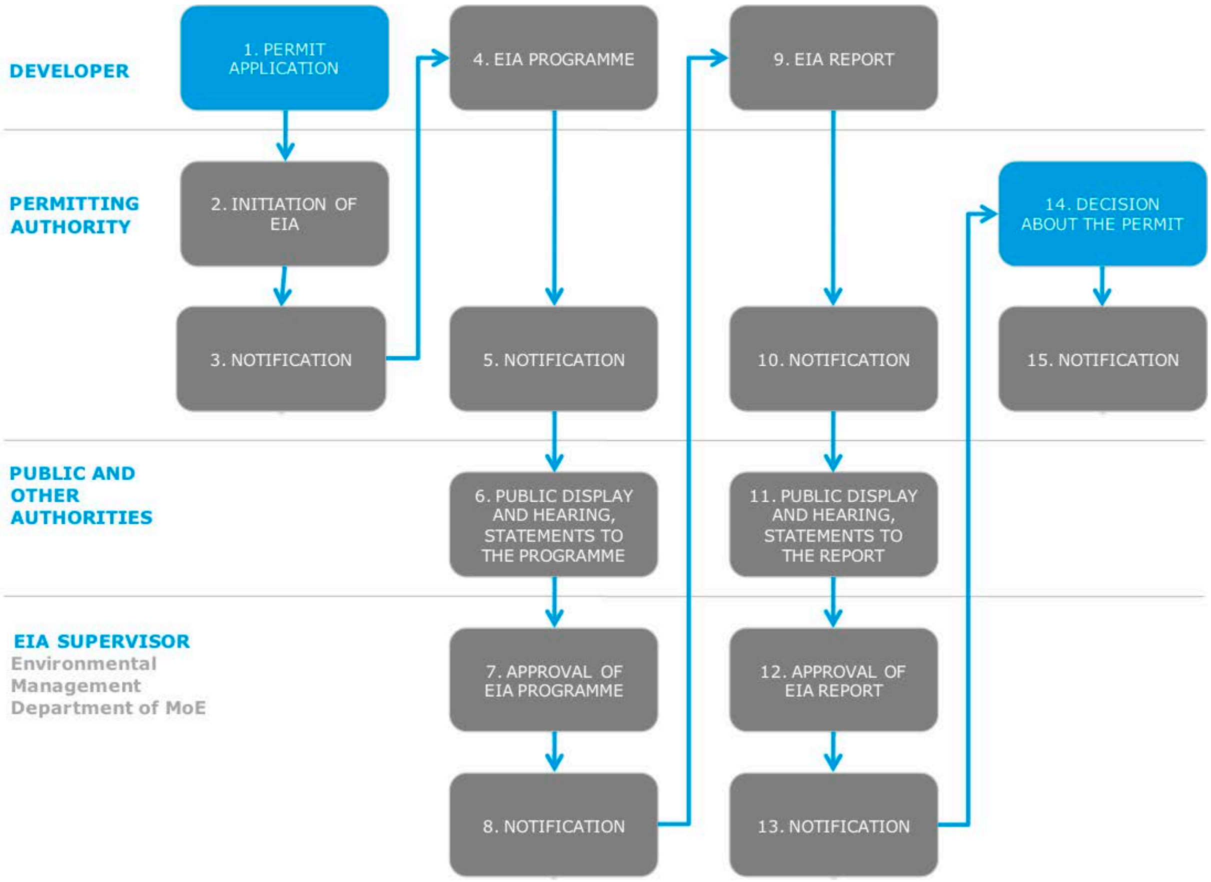


Figure 4-2. EIA procedure in Estonia *(Ramboll 2014c).*

4.2.3 EIA program phase

The EIA programme is compiled by the EIA licensed expert, the EIA working group and the developer. The project developer submits the EIA programme to the permitting authority for arranging the publication of the programme.

The EIA programme will be amended according to the results of publication and publication materials (public notices, minutes of the public meeting, received letters and answers to these letters) are added to the programme before submitting it for approval. (*Ramboll 2014c*).

The Ministry of Environment (MoE) acts as the supervisor in the EIA procedure in Balticconnector (transboundary EIA) case.

The party responsible for the project submitted the reviewed EIA program to the Estonian Ministry of the Environment on May 23, 2014. Due to certain incompletions found in the EIA program, the supplementation of the program was requested by the supervisor by a letter dated June 20, 2014. The supplemented and revised EIA program was re-submitted for approval on June 30, 2014. The Ministry of the Environment issued its decision on the approval of the EIA program by letter No 11-2/14/1093-9 of July 15, 2014.

4.2.4 EIA report phase

The EIA report is compiled by a licensed EIA expert and the EIA Working Group. The permitting authority notifies about publication of the EIA report in the same way as for the EIA program. The requirements for publication and review of the EIA report are similar to those for the EIA program.

Following the review of the EIA report, the Project Developer submits it to the Ministry of the Environment (MoE) for approval and determination of the environmental requirements. The MoE makes a decision to approve the EIA report within 30 days of receipt of the report and all related materials, and informs the Project Developer and permitting authority about its decision. The MoE submits a copy of the EIA report to the permitting authority.

The MoE informs about the approval of the EIA report and determination of environmental requirements in official announcements and by letter to the interested parties within 14 days of having made its decision. The EIA procedure concludes with the approval of the EIA report by MoE/EIA supervisor (*Ramboll 2014c*).

4.2.5 Permitting phase

After approval of the EIA report, the procedure of superficies license application will continue. The permitting authority must take into account the results of the EIA and the environmental requirements determined by the EIA supervisor (*Ramboll 2014c*).

If the EIA results and environmental requirements are not taken into account, the permitting authority must give an argumented justification in its decision to issue or refuse to issue the permit. A permit may not be issued if the developer is unable to comply with the determined environmental requirements (*Ramboll 2014c*).

As agreed with the MoE, a permit application for special use of water will be submitted to the MoE by the developer together with the EIA report. The special water usage permit will be applied after the superficies license has been granted.

The intention is to carry out an EIA, which gives information about possible impacts to all different permitting authorities, who will make a decision about permits related to the Balticconnector project (e.g superficies licence, permit for special use of water, building permit) and consider the necessity of the EIA (*Ramboll 2014c*).

Below (Table 4-1) is a summary of licenses and permits required in Estonia regarding alignment of the route, construction and operation of natural gas pipeline. Necessary permits and decisions of the implementation of the project in Finland are described in the Finnish EIA (*http://www.balticconnector.fi*).

Table 4-1. Permits needed for routing, construction, operation and safet use of the Balticconnector pipeline in Estonia *(Ramboll 2014c)*.

Activity	Permits in Estonia
Pipeline construction and pre-operational testing activities in territorial waters and EEZ	Special water usage permit according to Water Act § 8 section 2 points 1,7 and 9 from the Ministry of the Environment (MoE)
Environmental surveys concerning pipeline route location	Consent from the Estonian Government, permission granted from the Ministry of Foreign Affairs (MFA) to conduct surveys in the Estonian territorial waters and EEZ until December 30, 2013.
Pipeline route in EEZ's (right to use)	EEZ consent from the Estonian Government via MFA (EEZ Act); Superficies license according to the Water Act § 225 from the Estonian Government (permit to burden the Estonian sea area with a pipeline)
Construction of the gas pipeline through the Pakri special protection area	Permission from the administrator of nature protected areas (Nature Conservation Act § 14)
Import and transmission of gas in Estonian territory	Activity permit and 'gas market' permit from the Estonian Competition Authority (ECA) (Natural Gas Act § 27, 29 and 47)
Construction of the cross-border natural gas transmission pipeline	Permission from the Estonian Government (Natural Gas Act § 181)
Gaseous fuel safety in Estonian territory	Protection zone of the gas equipment determined by Estonian Government and registration by Estonian Technical Surveillance Authority (Gaseous Fuel Safety Act § 10 section 3 and §19 section 2) https://www.riigiteataja.ee/akt/176544
Operating as service provider	Permission from the Estonian Competition Authority
On-shore pipeline section from the point of landfall to the compressor station	Technical requirements for next steps and other relevant permits (e.g construction permit, etc) from the local municipality (Paldiski City Government)
State technical inspections	Estonian Technical Surveillance Authority(Gaseous Fuel Safety Act)

4.2.6 Projects of Common Interest (PCI)

The construction of key trans-European energy infrastructure projects (Projects of Common Interest, PCI) is promoted under Regulation (EU) No 347/2013 on guidelines for trans-European energy infrastructure (Infrastructure Regulation). A key aim of the Infrastructure Regulation is to facilitate the implementation of PCIs by, for example, coordinating and accelerating permit granting processes. The Balticconnector natural gas pipeline project is included in the list of PCIs published by the European Commission in October 2013.

The PCI process is a procedure within which the environmental impact assessment and permit granting procedures based on national legislation are carried out. The authorities in accordance with the national sectoral legislation are, however, still responsible for their statutory decision-making roles. In Estonia, the competent authority is the Ministry of Economic Affairs and Communications (MEAC), which is tasked with streamlining the assessment and permit granting procedures under the competence of other authorities by coordinating the processes as a whole.

In accordance with the decision made by the MEAC on February 26, 2014, a PCI working group was established to facilitate and coordinate the permit granting procedure relating to PCIs. The members of the working group also include representatives of the Ministry of the Environment and the Ministry of the Interior.

4.3 Schedule of the EIA procedure

The key stages and planned schedule of the EIA procedure are shown in the figure below.

After the supervisor's approval of the EIA, the report permitting authority (MEAC) will make a decision about the superficies license application.

4.4 Parties to the EIA procedure

The developers responsible for the project are Gasum Corporation and AS EG Võrguteenus. The coordinating authority (decision maker) of the project EIA procedure in Estonia is MEAC and supervisor the Ministry of the Environment (MoE). The international consultation procedure is coordinated in Estonia by the MoE.

The consultants Pöyry Finland Oy and Entec Eesti OÜ have compiled the environmental impact assessment report for Estonia. In addition to experts from Entec Eesti OÜ, experts from Pöyry Finland Oy, Merin Ltd, the Institute of Marine Systems and the Department of Mechanics of Tallinn University of Technology, Head OÜ, Geological Survey of Estonia, and Tirts & Tigu OÜ participated in the impact assessments in Estonia. The company responsible for preparation of the EIA program and technical project design is Ramboll. The experts participating in the project impact assessment work and their areas of responsibility for Estonia as well as Finland are shown in Table 4-2. A large group of experts (see section 12.3) also participated in the investigations and studies conducted during the EIA procedure.

Key roles in the EIA procedure were also played by citizens and the authorities representing a variety of sectors that have influenced the EIA procedure through contributions, including submitting their statements and opinions.

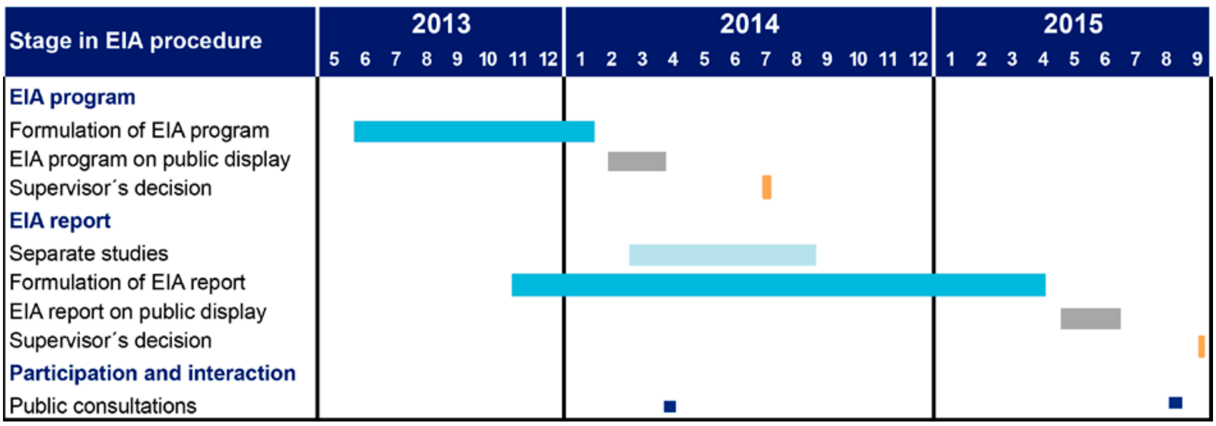


Table 4-2. The Finnish and Estonian EIA working groups.

	Finnish EIA working group	Estonian EIA working group
Project leader	Terhi Rauhamäki MSc, (Pöyry)	
Project manager	Terhi Rauhamäki MSc, (Pöyry)	Andres Piirsalu, MSc (OÜ Entec Eesti) Rein Kitsing, MSc (Merin Ltd) - lead expert (license No KMH0020
Project coordinator	Anna-Katri Räihä, MSc (Pöyry)	Kerttu Kõll, BA (OÜ Entec Eesti)
Marine hydrology	Lotta Lehtinen, MSc (Pöyry) Kari Kainua, MSc (Pöyry) Hannu Lauri, MSc (YVA Oy)	Urmas Lips, PhD (Marine Systems Institute at TUT) Germo Väli, PhD (Marine Systems Institute at TUT) Taavi Liblik, PhD (Marine Systems Institute at TUT)
Nature (including protected areas, **species and** **green network)**	Soile Turkulainen, MSc (Pöyry) William Velmala, MSc (Pöyry)	Natalja Kolesova, BSc (Marine Systems Institute at TUT) Inga Lips, PhD (Marine Systems Institute at TUT) Lauri Klein, MSc (OÜ Tirts & Tigu) Kerttu Kõll, BA (OÜ Entec Eesti)
Natura 2000	William Velmala, MSc (Pöyry)	Natalja Kolesova, BSc (Marine Systems Institute at TUT) Mariliis Kõuts, MSc (Marine Systems Instituteof at TUT)
Fish, fisheries	Sauli Vatanen, MSc (Fish and Water Research Ltd) Ari Haikonen, BSc (Fish and Water Research Ltd)	Mariliis Kõuts, MSc (Marine Systems Instituteof at TUT)
Marine biology	Ari Ruuskanen, PhD (Monivesi Oy) Lotta Lehtinen, MSc (Pöyry)	Natalja Kolesova, BSc (Marine Systems Institute at TUT) Inga Lips, PhD (Marine Systems Institute at TUT)
Marine geology	Henry Vallius, PhD (GTK)	Kaarel Orviku, DrScGeol. (Tallinn University, Institute of Ecology) Andres Kask, PhD (Geological Survey of Estonia) Sten Suuroja, PhD (Geological Survey of Estonia)
Soil, bedrock and groundwater, **coastal processes**	Maarit Korhonen, MSc (Pöyry)	Kalle-Mart Suuroja, PhD (Geological Survey of Estonia) Rein Kitsing, MSc (Merin Ltd) Kaarel Orviku, DrScGeol. (Tallinn University, Institute of Ecology)
Noise	Carlo Di Napoli, MSc (Pöyry) (onshore noise) Janek Laanearu, PhD and Aleksander Klauson, PhD (Department of Mechanics, Tallinn University of Technology) (underwater noise) Thomas Folegot, PhD (Quiet Oceans) (underwater noise)	
Air quality	Mirja Kosonen, MSc (Pöyry), Jüri Teder (OÜ Entec Eesti)	
Exceptional and accident situations	Mirja Kosonen, MSc (Pöyry)	
Traffic, traffic safety	Anna-Katri Räihä, MSc (Pöyry) Jaakko Kettunen, MSc (Pöyry)	Taavi Liblik, PhD (Marine Systems Institute at TUT) Germo Väli, PhD (Marine Systems Institute at TUT)

	Finnish EIA working group	Estonian EIA working group
Vibrations	Anna-Katri Räihä, MSc (Pöyry) Sakari Lotvonen, LSc, MSc (Pöyry)	
Land use, landscape and cultural heritage	Saija Miettinen-Tuoma, MSc (Ramboll) Mariikka Manninen, MSc (Landscape Archit) (Ramboll)	Kerttu Kõll, BA (OÜ Entec Eesti) Kaur Lass, MA (OÜ Head)
People and society	Jari Laitakari, eMBA (Pöyry) Ville Koskimäki, MSc (Pöyry)	Kaur Lass, MA (OÜ Head)
Use of natural resources, waste and waste management	Terhi Rauhamäki MSc, (Pöyry)	
Decommissioning	Terhi Rauhamäki MSc, (Pöyry)	
Zero alternative	Terhi Rauhamäki MSc, (Pöyry)	
Geographic information, maps	Jari Ruohonen, MSc (Tech) (Pöyry)	Kerttu Kõll, BA (OÜ Entec Eesti)

4.5 Participation in the EIA procedure

Environmental impact assessment work was carried out interactively with various stakeholders and authorities. About initiating of EIA procedure was publicly informed according to the law. The public display of the EIA program was held from February 10 to April 07, 2014 in both countries. Public meetings were organized by the developers in cooperation with the EIA program consultant.

Public meetings of the EIA program were held in Estonia at the Russian High School of Paldiski on April 15, 2014, and at the Ministry of Economic Affairs and Communications (MEAC) in Tallinn on April 16, 2014. Proposals, questions and objections about the project and EIA program could be submitted during public display and at the public meetings. In Estonia during publication, eight letters were received from the authorities, citizens and developer of Paldiski LNG terminal. These letters pointed out topics to be specified in the EIA program or dealt in the report. An overview of the proposals and if the proposals were taken into account, or explanations as to why they were not, is appended to the EIA program (see Appendix 1).

Comments from other countries (Lithuania and Finland) were taken into account while compiling the EIA report. Latvia was of the opinion that an EIA program is sufficient to conduct the impact assessment and does not wish to actively participate in the EIA procedure. Nethertheless, Latvia would like to receive information about the impact assessment results. Lithuania no longerwishes to participate in the EIA procedure. Russia has informed Finland about its wish to participate in the EIA procedure. The replies from other countries (Lithuania, Latvia, Finland, Estonia) are added to the EIA program.

Public display is organized and public meetings held also during the EIA report phase. The requirements of the publication and of amending the EIA report are similar to those for the EIA program. The EIA report will be delivered to the countries which had an opinion to participate in the EIA process according to the Espoo Convention.

Will be continued after public meeting...

Other communications

Information about the project and its environmental impact assessment has also been provided in conjunction with general communications, such as press releases, press articles and websites of the Project Developers.

5 CURRENT STATE OF THE ENVIRONMENT

5.1 Current state of the Gulf of Finland and of the sea area in Estonia

5.1.1 Bathymetry

The Baltic Sea is one of the largest inland seas in the world. It is, however, very shallow, with the average depth only being 55 m. There is major variation in water depth and seabed morphology. The depth of water in some of the deep basins of the Baltic Sea is several hundreds of meters. The Gulf of Finland is the eastern-most arm of the Baltic Sea bordering on Finland, Estonia and Russia, accounting for around 5% (1,100 km³) of the total water volume of the Baltic Sea. The average depth of the Gulf of Finland is 38 m, while the maximum depth is 123 m. The relatively flat morphology of the Southern Baltic Sea differs from the fragmented seabed of the Northern Baltic Sea, particularly its coastal areas and archipelago. These differences in seabed morphology and structure between the areas are mainly due to bedrock differences (*Baltic Sea Portal 2014*).

The depth of water along the route of the planned gas pipeline varies in the 0–93 m range. The seabed profile on the pipeline route is shown in the figure (Figure 5-1). The Gulf of Finland coast slopes more gently on the Finnish side than on the Estonian coast. There is an archipelago zone that is around 20 km wide off Ingå, Finland, where major changes in water depth are caused by bedrock ridges, mainly in the 5-25 m range.

In central parts of western Gulf of Finland the depth increases gradually and the average depth is around 80 m. The deepest point, 93 m, is located around 20 km from the coast of Estonia. On the Estonian coast the water depth increases rapidly towards to open sea. In the more western landfall alternative, ALT EST 2, the depth goes down to 35 m over a distance of around 4 km, while in the more eastern alternative, ALT EST 1, the increase in depth is slightly less rapid (*MMT 2014*).

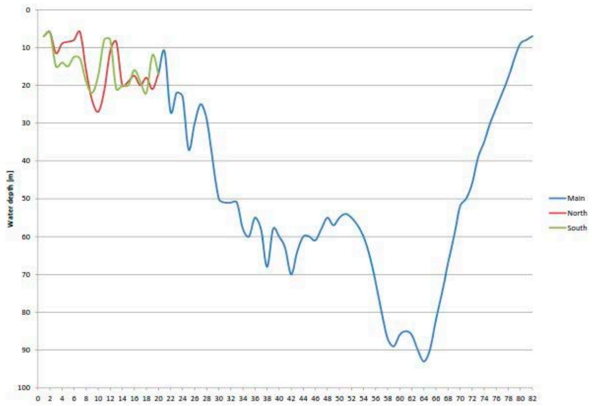


Figure 5-1. The vertical profile of the pipeline routing from Ingå to Paldiski. The green line refers to the routing alternative south of the island of Stora Fagerö, ALT FIN 1, and the red line to the northern routing alternative, ALT FIN 2 (Ramboll 2014a).

The sea area of the Estonian exclusive economic zone will include 33 kilometres of the Balticconnector route if constructing the landfall at the ALT EST 2 location (Pakrineeme) or 36.2 kilometres if constructing the landfall at the ALT EST 1 location (Kersalu). Within the route corridor, the seabed relief is fairly flat in the Estonian side.

In the area of the Kersalu route, the water is 2 m deep at 0.5 km and already slightly over 12 m deep at 1.5 km from the shoreline. The 10 m isobath is at 1.4 km and the 20 m isobath is at 4 km from the shoreline.

For the Pakri route option, the water is 8 m deep at 0.5 km, 10.5 m deep at 1 km and 13 m deep at 1.5 km from the shoreline. The 10 m isobath is at 0.8 km and the 20 m isobath is at 1.75 km from the shoreline.

In the section of the route at the Estonian end, the gradient of the slope is predominantly up to 0.5 degrees (*MMT 2014*). In the vicinity of the Pakrineeme landfall, the underwater nearshore of the Baltic Klint is covered by Quaternary sediments. Here, the gradient of the seabed is slightly greater, reaching up to two degrees at a distance of 1.6 km from the shoreline. From the Finnish shoreline, at Kilometer Posts (KP)57.1 to 82 of the route, the seabed is relatively even. In some areas along this segment, there are boulders (> 0.5 m) and, more frequently, pebbles and cobbles (< 0.5 m). At KP63.5 to 66.5, the water is deeper than 70 m. Here, the route intersects with a system of channels on the seabed, where several elongated traces of potential erosion 1–2 m deep occur in parallel. The falling slope terminates in a trench more than 10 m deep.

From KP 57.1 to the boundary of the Estonian Exclusive Economic Zone, the seabed relief is highly articulated. On the seabed, there are basement rock features: flatrocks. Here, slope gradients reach up to 15 degrees. The relative height of flatrocks reaches up to 20 m.

5.1.2 Seabed morphology and sediments

5.1.2.1 Geomorphology

The bedrock in the Gulf of Finland area is divided into two very different parts. The bedrock on the northern side of the gulf is consists of Precambrian crystalline rock, while the bedrock on the southern side consists of sediment rock layers on top of the bedrock aged a few hundred million years. The Precambrian bedrock is considerably harder and more durable than the sedimentary rock on top of it. Due to the differences in erosion tolerance between the Finnish and Estonian bedrocks, there are clear differences in bedrock topography between the two sides of the Gulf of Finland.

Although the Finnish coast is extremely irregular, its bedrock topography is still relatively more even than the klint topography of the Estonian coast characterized by peninsulas often with rather steep cliffs running north or northwest. The ancient deep valleys between the peninsulas are covered by sediment layers up to tens or even a hundred meters thick. The depth of water in these bays and inlets of today can be up to 40–50 m, with the outermost sections of the deepest bays being up to a maximum of 90 m. The bedrock on the Estonian coast is exposed in places but often covered by sediments. This also applies to the seabed (Figure 5-2.).

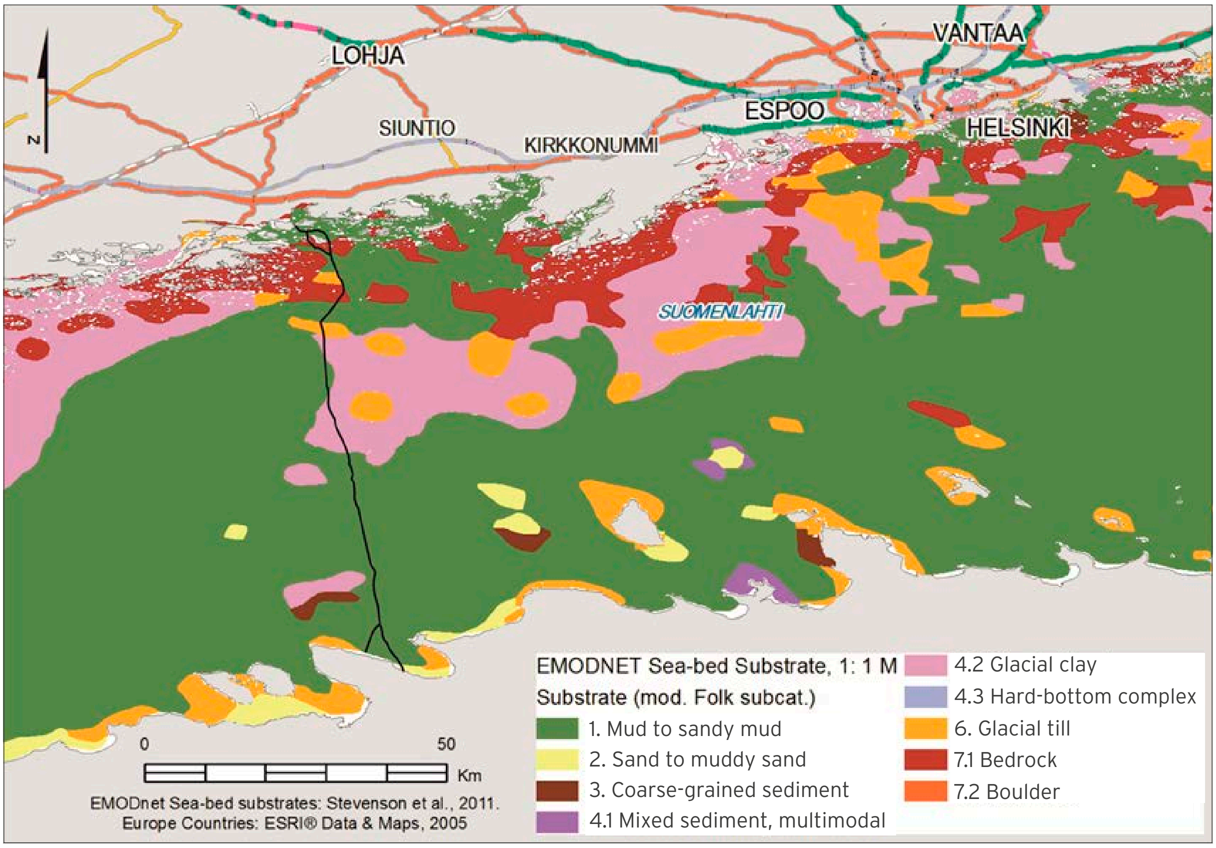


Figure 5-2. Seabed sediments in the western Gulf of Finland, European Marine Observation and Data Network (EMODnet) seabed substrate map. (Stevenson 2011)

In the Estonian exclusive economic zone, the southern section of the gas pipeline lies on the Palaeozoic plain (plateau) of the Gulf of Finland, its central section in the area of the basin of the Gulf of Finland, and its northern section on the slope of the Fennoscandian Shield. The area of the Pakrineeme landfall (ALT EST 2, KP 77.9 km) of the pipeline route includes the nearshore of the Baltic Klint, where the sandstone scarp descends approximately 8 m at a distance of 500 m from the shoreline. In the area of the Kersalu landfall (ALT EST 1, KP 81.4), the underwater bedrock scarp of sandstone is lower (approximately 4 m high) and buried under Quaternary sediments. The area where the two route options meet lies on a limnoglacial plain, to the north of which lies the plain of the basin of the Gulf of Finland.

Crystalline basement rock

The aperture area of crystalline basement rock lies to the north of KP 57.1 of the route. Here, the basement rock consists of metavolcanic rock that has turned into migmatite and has a composition that is alkaline to acidic – various types of gneiss. The top cover of the basement rock descends toward the south and is covered by sedimentary rock and Quaternary sediments. To the south lies the basement rock of granite of Naissaare. In the area of the landfalls, the basement rock is at a depth of approximately 150 m.

Bedrock

In the south section of the route, the bedrock is made up of Ediacara and Lower Cambrian terrigeneous sedimentary rocks: sandstone, silt and clay. In the north section of the route, there is no cover of sedimentary rock, and metamorphic and igneous rocks in the crystalline basement rock are exposed beneath the Quaternary sediments.

Bedrock relief

The pipeline landfall at Kersalu, the top cover of bedrock is at depths of 2–4 m at 1.3 km and at depths of 4–16 m at 4.5–7 km from the shoreline.

At the Pakrineeme landfall of the proposed route, up to 1.6 km from the shore, the bedrock is covered by a relatively thin (up to 4 m) stratum of Quaternary sediments. At 1.6–2 km from shore, the top cover of the bedrock drops dramatically, and is covered with sediments approximately 10 m deep.

Along KP 73–80 of the route, the top cover of the bedrock is at a depth of 8–16 m from the seabed. The top cover of the bedrock is at a depth of 8–22 m along km 68.5–73.0 of the route, and at a depth of 16–24 m at a distance of 65.5–68.5 km. At KP59.5–63.5, geophysical methods of investigation have been unable to determine the depth of the top cover of the bedrock, since the top layer of sediments contains gas.

A transitional area, with no bedrock but with a top cover of sediments resting directly on the basement rock, extends from KP57–59 s (*MMT 2014*). Then, up to the boundary of the Exclusive Economic Zone, the relief of the bedrock (crystalline basement rock) has an articulated top cover. Between rocks exposed on the seabed, there are trenches filled with sediments up to a depth of 40 m.

Quaternary sediments

The sea area of the Estonian Exclusive Economic Zone may be divided into three areas based on the distribution of Quaternary sediments (*MMT 2014*):

- Coarse-grained sediments (moraine, sand and gravel with boulders and cobbles) occur at both landfall locations to a distance of 6.5 km from the shoreline. Zones of boulders and cobbles occur frequently; that said, distribution areas of sand, covered by wave ripple marks, occur near either landfall.
- Soft clay dominates the route corridor on the Estonian side along km 6.5–25 from shore. Areas of potential trawling tracks on the seabed occur in the area of homogeneous clay, there is also sand in smaller areas. Soft clay is made up of the black and greenish grey silty and pelitic sediments of the Littorina / Limnea Sea, and the clays with intermediate layers of hydrotrilite of the Yoldia Sea and Ancylus Lake.
- The aperture areas of basement rock are surrounded regularly by sand and gravel, soft or hard clay (loam moraine of glacial origin). The moraine contains cobbles and boulders, and surrounds the aperture area of the basement rock in a circular bank. Often, sediments with higher clay content are overlain by a thin layer of mixed-grained sand and / or gravel.

5.1.2.2 Bottom sediments

To a depth of 9 m in the sea area of the Pakrineeme route alternatives, the seabed is covered by moraine (*MMT 2014*). At depths of 9–10 m, a zone of cobbles occurs. Between the cobbles, there is sand and gravel. From 10–15 m, there is an area of sand with wave ripple marks, replaced by a distribution area of very soft to soft clay from the approximately 20 m isobath onward.

On the Kersalu route, moraine, gravel and sand vary on the seabed to a depth of 12 m. In the sand and gravel area, there are wave ripple marks. At depths below 12 m, sand and gravel, and a zone of cobbles at an average frequency occur across an extensive area. The latter extends to approximately 26 m below sea level. At depths of 26.5,28.5 m below sea level, there is a small distribution area of strong clay. At a depth below 32 m, sand is replaced by soft to very soft clay.

At 35–45 m below sea level, there are distribution areas of sand with wave ripple marks. At 45–76 m below sea level, soft to very soft clay occurs. To the north of the isobath of 78 m below sea level, elongated trenches and banks from the northeast to the southwest (west) (2–3 m high and 50–100 m wide) occur.

At 18 km from the Estonian shoreline, the water runs over 100 m deep about 100 m from the route in West. Then, the seabed rises againto reach 82 m below sea level in the 20 km area. In the areas at 22.5, 23 and 24.5 km from the shoreline, the water still runs over 90 m deep. From 24–25 km, there are distribution areas of loam moraine. From 25 km to the boundary of the Estonian Exclusive Economic Zone, there occur basement rock aperture areas surrounded by zones of sand, gravel, and soft and loam moraine. Harder loam moraine contains cobbles and often surrounds the aperture area of the basement rock in a bank.

Whereas clays occur on the seabed relatively homogeneously, coarse-grained sediments (boulders, cobbles, gravel or sand) occur more heterogeneously, and their sediment type may vary several times even across a segment of 100 m.

Areas of more coarsely grained sediments and basement rock ran from Estonian shoreline at 24.9 to 25.9 km; 28.4 – 29.0 km: 30.0 – 30.3 km; 30.8 – 31.1 km; 31.4 – 31.6 km of the route. Small isolated apertures to the basement rock lie within ranges approximately at kilometres 27.0; 30.5; 30.7; 32.0; 33.4; 33.7 and 35.2 from the Estonian shoreline.

Individual cobbles and boulders occur across the entire route area; however, the numbers are particularly high in the distribution area of moraine, and where there are apertures to the basement rock. Boulders also occur in areas interpreted as distribution areas of hard clay (moraine). In the distribution areas of soft clay, there are virtually no boulders.

Sediment samples

Throughout its history, the Baltic Sea has received heavy metals from a variety of sources, including river water, coastal erosion and, to a slightly lesser extent, from the atmosphere. These used to originate from the natural environment, but human activities have resulted in an increase in the quantities of pollutants in the Baltic Sea. The Baltic now faces a large number of different organic pollutants and point source input from a variety of sources such as sewers, shipyards and marinas as well as airborne inputs. In the seabed the pollutants are mainly bound to the finest-grain material, corresponding to clay in terms of grain size. This is due to the fact that the particles of the fine fractions are negatively charged and have a large specific surface area to which positively charged heavy metals are fixed. Pollutants are also to some extent fixed by organic matter.

In 2013, samples were taken from bottom sediments to determine the texture, hazardous substance concentrations, and the species composition, numbers and biomass of benthic fauna in bottom sediments (*Lips 2013)*, for station locations see Figure 5-3. In terms of hazardous substances, the concentrations of heavy metals (As, Hg, Cd, Co, Cr, Pb, Ni and Zn), organostannic compounds (tributyltin TBT and triphenyltin TPT), dioxins (polychlorinated dibenzodioxins: PCDD-TCDD, PeCDD, HxCDD, HpCDD and OCDD; and polychlorinated dibenzofurans: PCDF–TCDF, PeCDF, HxCDF and OCDF) and radionuclides in the sediments were determined.

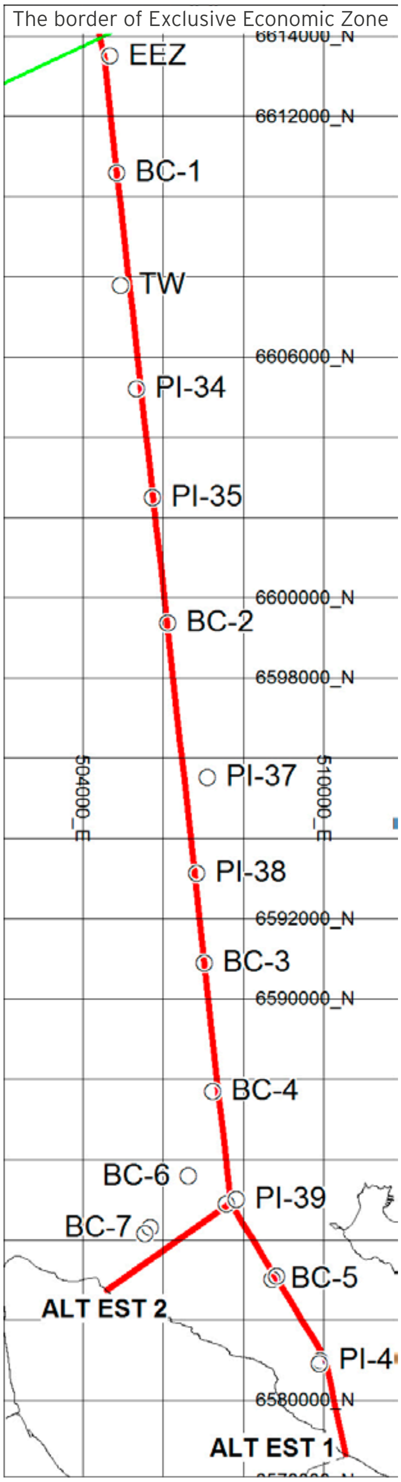


Figure 5-3. Bottom-sediment monitoring stations in 2013.

Table 5-1. Minimum, average and maximum concentrations of hazardous substances (mg/kg) in the seabed material.

Metal	Minimum (mg/kg)	Average (mg/kg)	Maximum (mg/kg)	Limit values Regulation of the Minister of Environment No. 38 on August 11, 2010, Annex "The limit values for hazardous substances in the soil"		
				Target value (mg/kg)	Limit value in the residental area (mg/kg)	Limit value in the industrial area (mg/kg)
Mercury (Hg)	<0.10	<0.10	<0.10	0,5	2	10
Cadmium (Cd)	<0.20	0.4	0.88	1	5	20
Lead (Pb)	5.1	16.5	38	50	300	600
Nickel (Ni)	3.2	31.1	58	50	150	500
Arsenic (As)	1.8	7.7	15	20	30	50
Cobalt (Co)	1.2	12.4	24	20	50	300
Chromium (Cr)	5.7	50.3	96	100	300	800
Copper (Cu)	<10	33.7	56	100	150	500
Zinc (Zn)	9.7	87.5	170	200	500	1000

Furthermore, the concentrations of total nitrogen, phosphorus, organic carbon and water in the sediments were determined.

Heavy metals and organostannic compounds were analyzed in samples from 15 stations. Dioxins were studied in samples from 10 stations. Radionuclides were analyzed in samples taken from two stations. The texture of bottom sediments was determined in samples from 19 stations.

Predominantly, samples were taken from the top 20 cm layer of the bottom sediments. At station PI-37, a sample was taken also from a deeper interval (20–40 cm).

Texture analysis determined the proportions of the following fractions: < 0.002 mm (clay); 0.002–0.063 mm (silt); 0.063–2 mm (sand); 2–64 mm (gravel).

Textural composition of sediment

The proportion of clay fraction was over 75% in the sample from stations TW and PI-34. In samples taken from stations EEZ, BC-1, PI-35, BC-2 PI-37, PI-38 and BC-3, the proportion of clay fraction was 31.9% – 46.1%. In samples taken from stations BC-4 and BC-6, the proportion of clay fraction was 18.4% and 20.6%, respectively. At stations in the mouth of Lahepere Bay (PI-39 and BC-7) and inside the bay (BC-5 and PI-40), clay fraction had the lowest proportion.

In samples taken from stations BC-4 and BC-6, the proportion of silty fraction was 60%-65%. At stations in the mouth of Lahepere Bay (PI-39 and BC-7) and inside the bay (BC-5 and PI-40), sand fraction had the highest proportion (from 55%). The proportion of the sand fraction reached 80% in the sample from station PI-40. In all of the samples, the proportion of gravel fraction was below 10%.

Heavy metals

Concentrations of heavy metals were compared to the limit values for hazardous substances in the seabed material as established under Regulation of the Ministry of the Environment No 38 of August 11, 2010 (*RT I 2010, 57, 373,* see Table 5-1). The limit values for hazardous substances in the seabed material are expressed as the maximum and target value and are presented in milligrams per kilogram of dry mass of seabed material. The target value indicates a concentration of the hazardous substance in the seabed material at a level above which the seabed material is considered polluted. The target value indicates a concentration of the hazardous substance in the seabed material at or below the level of a value where the condition of the seabed material is deemed to be good.

The bottom sediments are in a good condition in the areas of most stations. Analyses of heavy metals indicate that the samples from all the stations contained mercury, cadmium, lead, arsenic, chromium, copper and zinc below their relevant target value. The concentration of nickel in the samples taken at stations TW and PI-34, and the concentration of cobalt in the sample from station TW were between the residential area range of the target value and the maximum. In terms of nickel and cobalt, the sediments at station TW are in a satisfactory condition. At station PI-34, sediments are in a satisfactory condition in terms of nickel concentrations. Sediments are considered polluted if the concentration of the relevant element exceeds the maximum. At no station did the heavy metal concentration in the sediments exceed the maximum, and thus there is no pollution.

Dioxins

The concentration of the chemical compound 1,2,3,4,6,7,8-HpCDF reached 0.062 ng/g. Concentrations were highest in the samples from stations PI-37 (0.062 ng/g) and PI-35 (0.032 ng/g). There were lower concentrations (up to 0.002 ng/g) in samples taken from stations TW and BC-5.

Concentrations of the chemical compound OCDF were highest in the samples from stations PI-37 (0.065 ng/g) and PI-35 (0.055 ng/g). There were lower concentrations (up to 0.005 ng/g) in samples taken from stations TW, BC-3, BC-5 and BC-7. (*Lips et al 2013 and TTÜ Mereuuringute Instituut & TÜ EMI 2011*). The concentration of dioxins detected in the samples taken as part of the study of the impact of the construction of the Nord Stream pipeline conducted in the Gulf of Finland was within a similar range.

Organostannic compounds

The concentrations of tributyltin (TBT) were highest in the samples from the top 20 cm sediment layer at station PI-37 (17 μm/kg), PI-35 (12 μm/kg) and EEZ (8 μm/kg). In the bottom sediment layer at station PI-37, the concentration of TBT was below the detection limit.

The concentration of TBT was at or above the detection limit also in the samples from stations BC-1, BC-2, PI-38, BC-6 and PI-39. Concentrations were below the detection limit of 1 μm/kg at eight stations.

The concentration of triphenyltin (TPT) was highest (15 μm/kg) in the bottom (20–40 cm) sediment layer at station PI-37, with the concentration of TPT in the top layer up to 20 cm below the detection limit.

The concentration of triphenyltin exceeded the detection limit at another three stations: EEZ, BC-1 and PI-35, where their concentrations range 6–8 μm/kg.

Radionuclides

Concentrations of radionuclides – 40K, 137Cs, 226Ra, 232Th and 238U – were determined based on the top 5 cm sediment layer and the bottom sediment layer ranging 5–10 cm at stations EEZ and PI-38. The concentrations (Bg/kg) are shown in the table (Table 5-2).

Table 5-2. Concentrations of radionuclides at stations EEZ and PI38.

Station (interval)	40K	137Cs	226Ra	232Th	238U
EEZ (0–5 cm)	1060±80	27.5±3.3	50±29	53±7	71±50
EEZ (5–10 cm)	1120±180	0.45±0.18	52±26	68±11	72±26
PI-38 (0–5 cm)	510±60	36±4	22.9±14.2	26.3±3.2	39±15
PI-38 (5–10 cm)	740±70	1.57±0.22	43±10	40±4	62±15

The concentration of 137Cs was several times lower than the results obtained by Estonia's national environmental monitoring or the concentrations in the HELCOM report (*HELCOM 2007*).

The concentration of 40K was at levels similar to the results obtained by Estonia's national environmental monitoring and the concentrations in the HELCOM report (*HELCOM 2007*).

The concentration of 226Ra was at levels similar to the concentrations in the HELCOM report (*HELCOM 2007*).

5.1.3 Glacial isostasy and post-glacial rebound

During the last ice ages the Baltic Sea basin was subjected to strong pressure as the area was depressed by heavy masses of ice. In the area currently the Gulf of Finland, the bedrock was suppressed by the ice masses by tens of meters, and the post-glacial rebound is still taking place, which can be seen as uplift of land. The rate of rebound varies around the Baltic Sea and is approximately 0.3–0.6 cm a year in the Gulf of Finland area. Furthermore, the rate of rebound in the Baltic Sea basin is different at the different ends of the basin, resulting in different rates of impact on the seabed in the different parts of the basin. When undergoing uplift, sediments become exposed to the impacts of waves and currents, which increases the amount of material detached from sediment due to erosion. Due to the hardness of the bedrock, however, the uplift rate is not even. Instead, it often takes place spasmodically. The rate of this neotectonic motion is usually small, with no mentionable earthquakes usually occurring due to glacial isostatic adjustment in the Baltic Sea area. However, so called Osmussaar Earthquake with magnitude ~4.75 took place in 1976.

5.1.4 Munitions and waste dumped in the sea

Both conventional munitions (such as depth charges, grenades and torpedoes) as well as chemical munitions were dumped in the Baltic Sea during and after the First and Second World War. Naval exercises are still undertaken in the Gulf of Finland, with munitions detected destroyed by exploding them in designated areas. Considerable amounts of chemical munitions were also dumped in the Baltic Sea during and after the Second World War. This dumping continued until 1972, which is when the dumping of toxic wastes in the sea was prohibited under the London Convention. There is no specific information available about the locations of the munitions dumped in the sea.

Marine litter is a growing problem around the world. Litter ends up in the sea from land-based activities as well as maritime activities. This litter consists of man-made products that are typically very slowly degradable. Litter is also often washed ashore by sea currents, but it is estimated that up to 70% of all marine litter ends up resting on the seabed. Plastic litter is the type of litter most commonly found in the Baltic Sea. In addition to plastic bottles and bags, items such as glass, rubber, metal, clothes, fishing nets, packaging materials, paper, cardboard and wood are found in the Baltic Sea. (*Baltic Sea Portal 2014*)

Of the total of 48 man-made objects (including munitions, metal waste, barrels) detected in the Balticconnector project study corridor, eight have been classified as probable munitions. Six of these are on the Estonian side and two on the Finnish side *(MMT 2006* and *MMT 2014)*.

5.1.5 Currents

The general circulation in the surface layer of the Gulf of Finland is characterized by a cyclonic flow pattern that is expressed as outflow in the northern part of the gulf and inflow in the open part of the Baltic Sea along the southern shore of the gulf (*Alenius 1998*). Recent modeling results have shown that in close proximity to the Estonian shore, there may be prevailing westward flows (Figure 5-4). The described residual circulation is relatively weak – velocities do not exceed 5 cm/s. In order to describe a possible distribution of environmental pollution stronger movements are important, with time scales of several days, that are related with mesoscale vortices, fronts, upwellings and jet currents (*Pavelson 2005*). In the case of the mentioned physical processes, the typical current speed is 20–30 cm/s and maximum velocities can reach up to 100 cm/s.

The water column of the Gulf of Finland is strongly stratified as is also expressed in the vertical structure of currents – in the surface layer there is a predominant outflow from the gulf and in the deeper layers there is inflow to the gulf. The flow structure mentioned can be stronger or weaker depending on meteorological influences, or it can be reversed in certain conditions (*Elken 2003*). It is important to state that although the current speed in deeper layers is lower on average, there can be short-term events where current speed near the seabed can reach 40 cm/s or more (*TTÜ MSI 2011*).

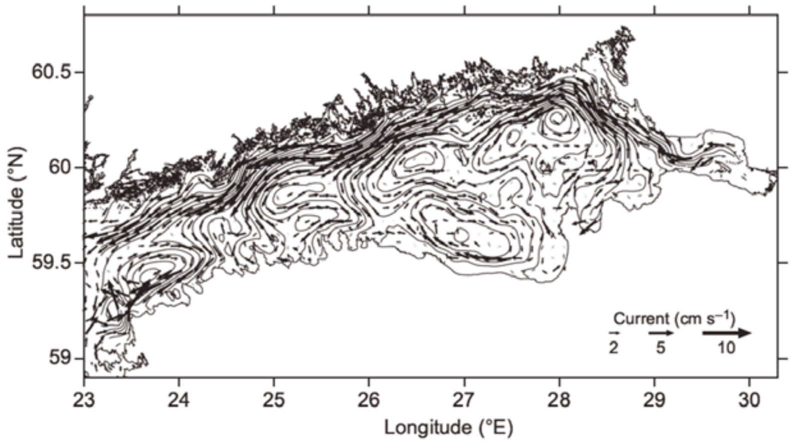


Figure 5-4. Average currents in the surface layer of the Gulf of Finland during 20062008 according to the results of HIROMB model (*Elken 2011*).

To describe the pattern of currents in the working area, samplings of HIROMB model (*Funkqvist 2001; Lagemaa 2012*) in three different spots along the planned pipeline are used from January 1, 2012 to October 14, 2014. Point P2 describes the pattern of currents in the Estonian coastal sea; point P3 describes the pattern of currents in the open sea in the southern part of the Gulf of Finland and point P4 describes the pattern of currents in the open sea in the central part of the Gulf of Finland. In order to describe the pattern of currents, also the measurement data of currents from the database of TUT Marine Systems Institute is included from two points closest to the work area (Figure 5-5, points M1 and M2). Data from point M1 characterizes the pattern of currents in the work area in the Estonian coastal sea in the area of a relatively steep slope of the seabed, and data from point M2 characterizes the pattern of currents in the deeper open sea section of the Gulf of Finland. Measurements were taken during the period of March 13 to June 30, 2009 in point M1 and during December 21 to May 9, 2011 in point M2.

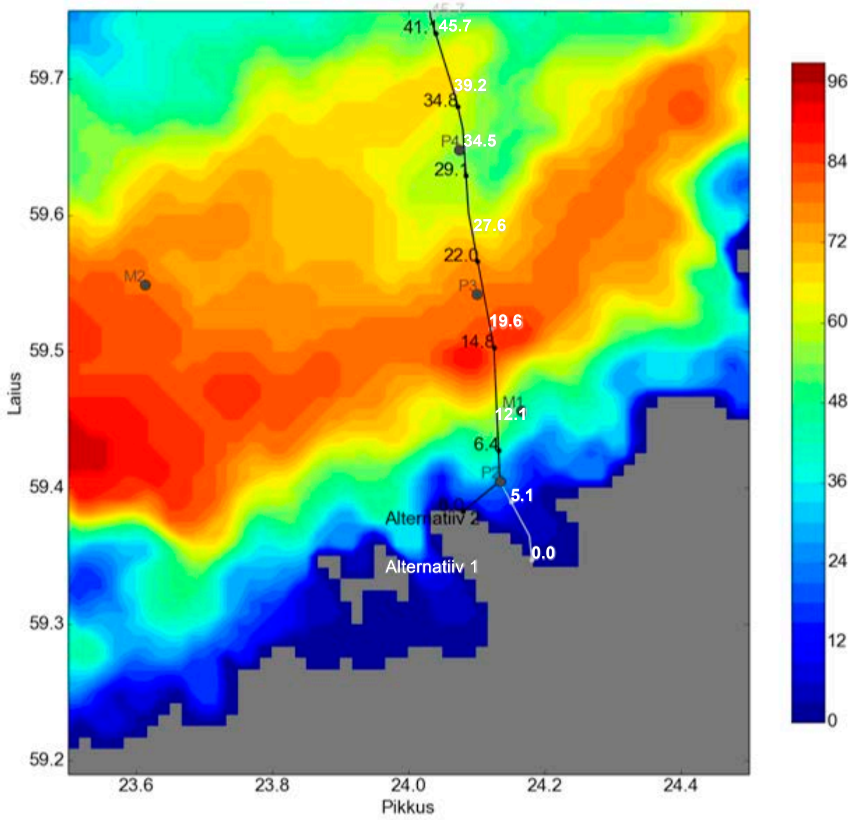


Figure 5-5. Bathymetry of the HIROMB model, Balticconnector alternatives and positions of the used measurements of currents and samplings of time series of the model results.

To characterize the currents, the results of the model from the surface layer (3 m) and bottom layer and 6–9 m above seabed were used (in order to characterize currents at a depth where uplifted sediments can incur in case of disturbances at the bottom). Sampling of the current speed and direction of the bottom layer was taken 21 mfrom point P2, 81 m from point P3 and 54 m from point P4. The temporal resolution of the samplings is one hour.

According to the modeling results, the average current velocity in the Estonian coastal sea (in point P2) during 2011–2014 was approximately 6 cm/s, while during individual events the velocities reached over 20 cm/s (maximum velocity was 55 cm/s). The current was predominantly directed to the west (more than 30% of time) or east (18% of all observed events).

In deeper layers, the current was weaker, average current speed being approximately 3 cm/s at a depth of 15 m and 2.4 cm/s at a depth of 21 m. During individual events, current speed was over 8 cm/s and maximum speed was 16 cm/s at a depth of 15 m and 12 cm/s at a depth of 21 m. In the middle layer (15 m) the current was predominantly directed to the west or southwest, but there were also currents with a speed of 8 cm/s directed to the east. Northward and southward currents were comparatively scarce (less than 12% of the time in total). In the bottom layer (21 m), the current was predominantly directed to the southwest (more than 40% of the time) and most infrequent directions were east and southeast (less than 16% of the time).

According to modeling results, the average current speed during 2011–2014 in point P3 in the subsurface layer was approximately 10.2 cm/s and during individual events the speed reached over 40 cm/s (maximum speed was 100 cm/s). In the subsurface layer, the current was predominantly directed to the northeast (more than 18% of the time) or southwest (more than 15% of the time). There were also occurrences of periods of greater current speed with currents directed to the west.

At a depth of 72 m, the average speed of the current was 5.7 cm/s and maximum speed was up to 35 cm/s. Direction distribution was strongly anisotropic and the current was predominantly directed to the northeast (33% of the time), but there was also a strong southwest flow (more than 21% of the time). Other directions of currents occurred less frequently.

At a depth of 81 m, the average current speed was slightly over 4.0 cm/s. During individual events, the current speed exceeded 15 cm/s and the maximum speed was slightly over 20 cm/s. Current direction distribution was also mostly anisotropic. The bottom current was predominantly directed to the northeast (more than 42% of the time) or southwest (more than 25% of the time).

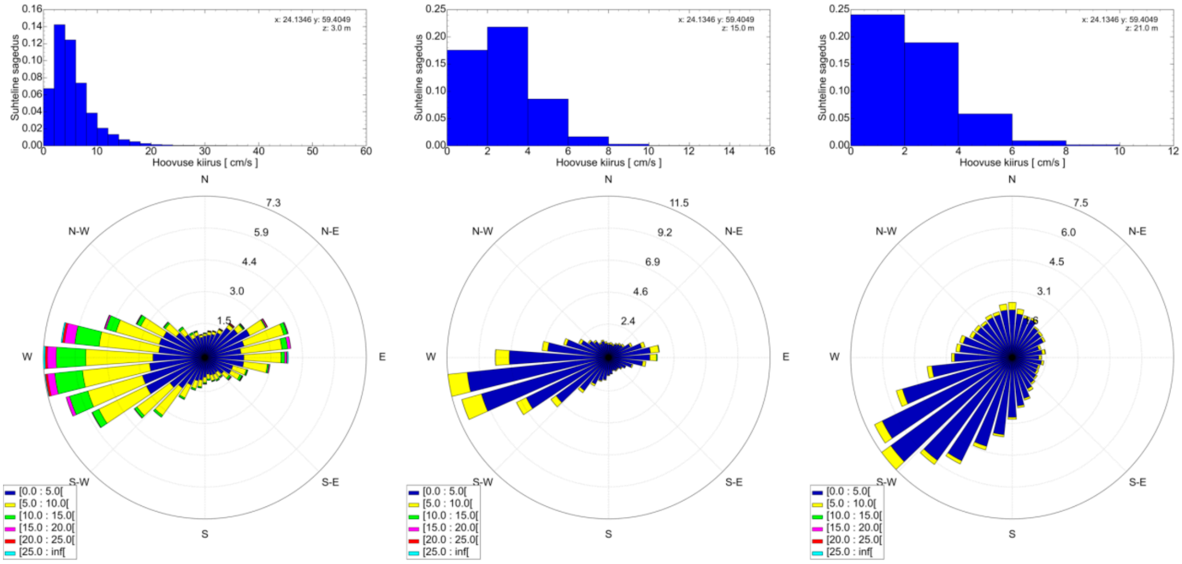


Figure 5-6. Density distributions of current speed probabilities (upper panel) and directional velocity distributions (lower panel) in point P2 (Estonian coastal sea; see Figure 5-5) in the subsurface layer (left), bottom layer (right) and 6 m above te seabed (middle panel) during the period of 1 January 2011 October 14, 2014.

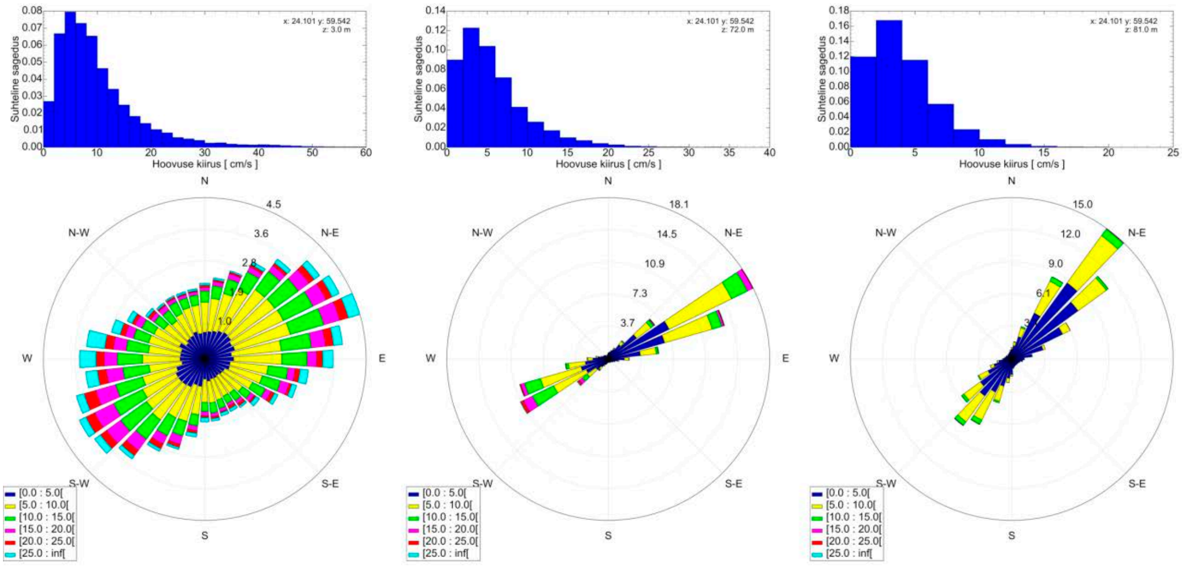


Figure 5-7. Current speed probability density distributions (upper panel) and direction-velocity distributions (lower panel) in point P3 (in the deepest part of the gas pipeline in the Estonian section; see Figure 5-5) in subsurface layer (3 m, left), bottom layer (81 m, right) and 9 m above seabed (72 m, middle panel) during the period of 1 January 2011 October 14, 2014.

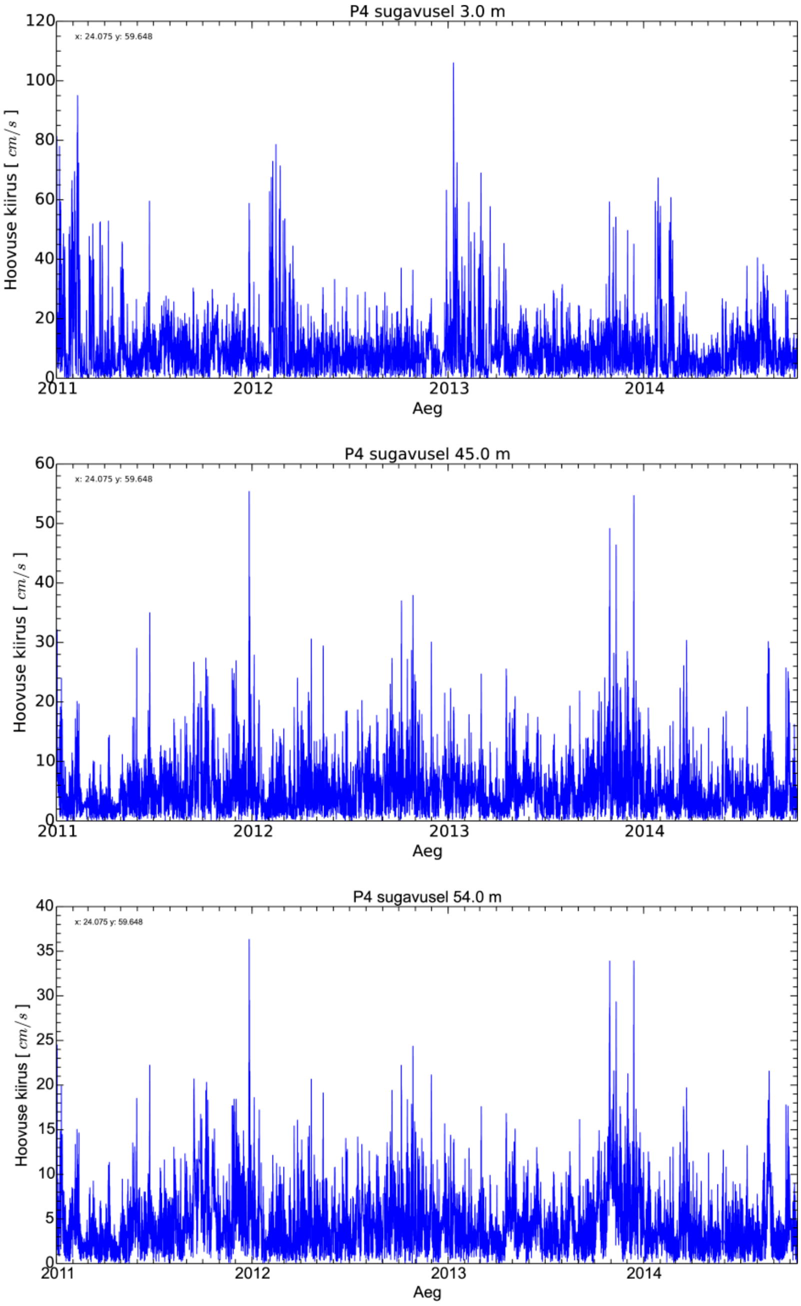


Figure 5-8. Time series of current speed from point P4 (middle part of the Gulf of Finland, see Figure 5-5) at subsurface layer (3 m, upper panel), bottom layer (54 m, lower panel) and at 9 m from the seabed (45 m, middle panel) during the period of 1 January 2011 October 14, 2014.

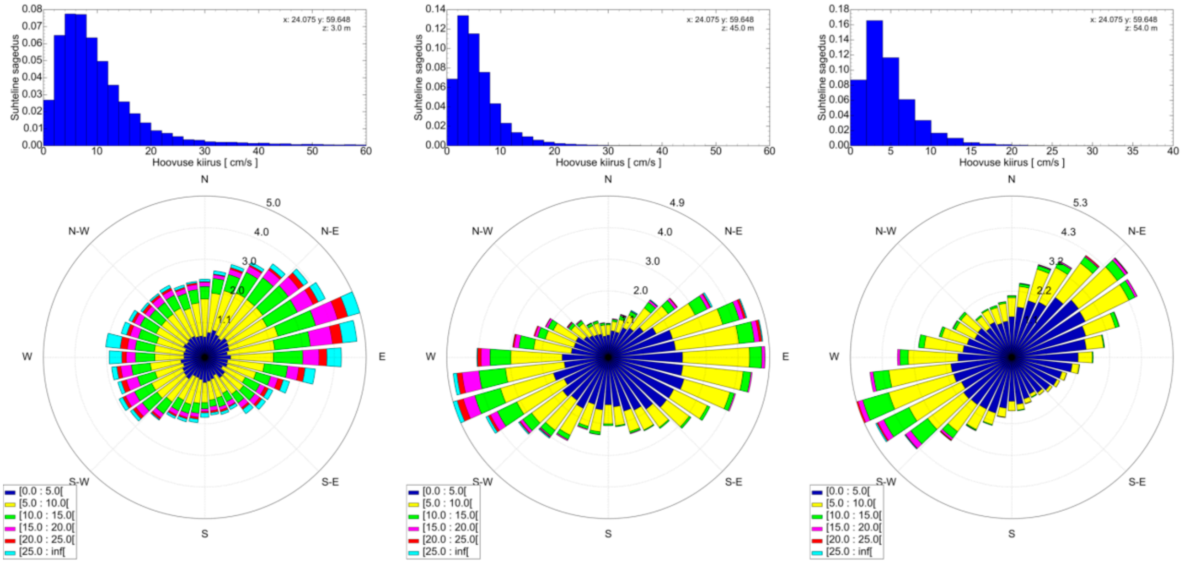


Figure 5-9. Current speed probability density distributions (upper panel) and direction-velocity distributions (lower panel) in point P4 (in the middle part of the Gulf of Finland; see Figure 5-5) in subsurface layer (3 m, left), bottom layer (54 m, right) and 9 metres from the bottom (45 m, middle panel) during the period of 1 January 2011 October 14, 2014.

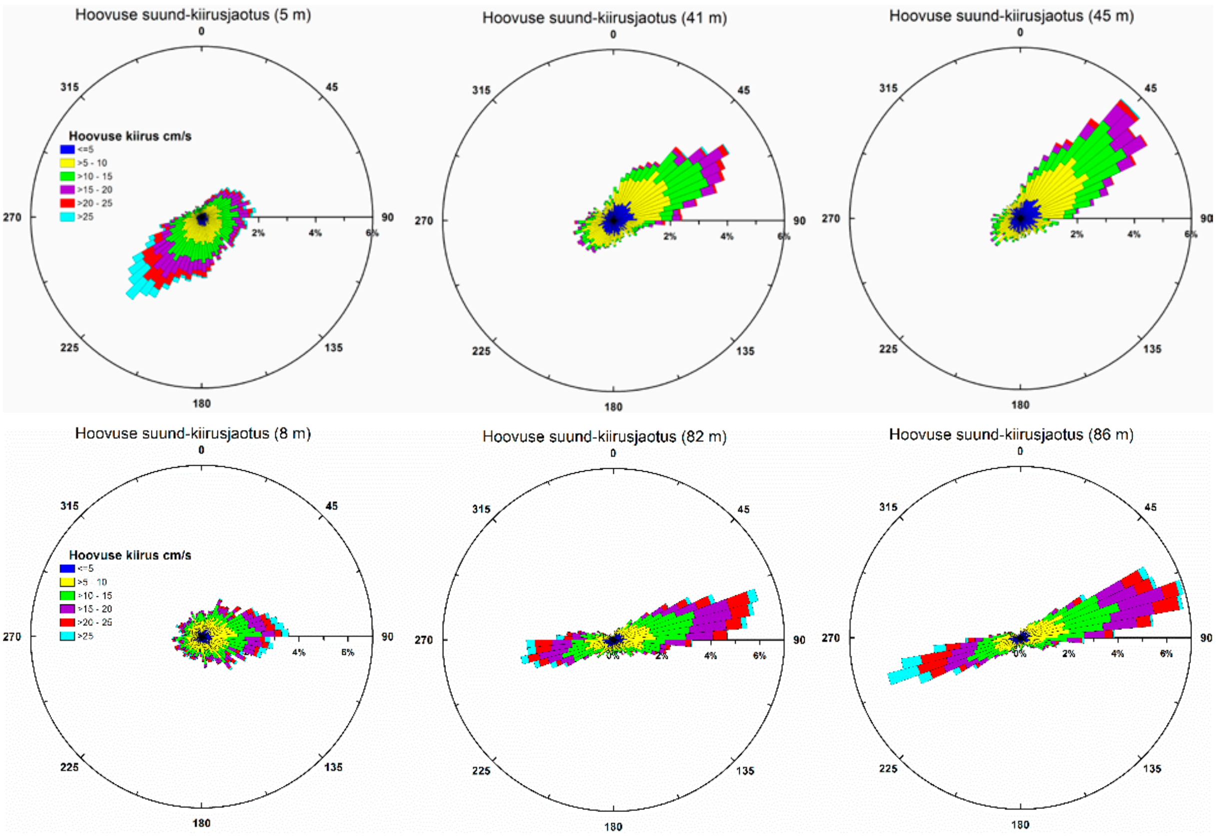


Figure 5-10. Current direction-velocity distributions in station M1 (upper panel; station location in the Estonian coastal sea by the slope, see Figure 5-5, measurement period March 13,-June 30, 2009) in surface layer (5 m, left), at a depth of 41 m (middle) and bottom layer (45 m, right) and at station M2 (lower panel; in the open part of the Gulf of Finland, see Figure 5-5, measurement period December 21, 2011–May 9, 9,2012) in surface layer (8 m, left), at a depth of 82 m (middle) and in the bottom layer (86 m, right).

Long-term average current speed in the subsurface layer was 10.5 cm/s and during individual events, there was current speed exceeding 60 cm/s (maximum speed was slightly over 100 cm/s). Current was predominantly directed to the northeast and east (35% of the time) or southwest and west (more than 11% of of the time). There were also occurrences of strong currents directed to the west.

In open sea, the direction distributions in the bottom and middle layer were more uniform in comparison to the points closer to the Estonian coastal sea. At a depth of 45 m, the average current velocity was 5.8 cm/s, but there were occurrences of velocities over 30 cm/s (maximum velocity was over 50 cm/s). Currents were predominantly directed to the west and southwest (more than 32% of the time, speed often greater than 18.5 cm/s) or to the east and southeast (more than 33% of thetime, but currents were weak, predominantly under 6.2 cm/s). In the bottom layer of the open sea, the average long-term current speed was 4.7 cm/s. During individual events, the current speed reached over 20 cm/s (maximum speed was slightly over 35 cm/s). The bottom current was predominantly directed to the northeast (more than 18% of the time) or southwest (more than 17% of the time).

Current measurements carried out over the recent years in the Estonian coastal sea and the open part of the Gulf of Finland also confirm that the currents in the area are subject to great variability both in terms of time and space. According to the measurement results shown in Figure 5–10, the currents in the Estonian coastal sea (in the work area) are predominantly directed along the coast or a steep northward inclined slope. During the measurement period of March 13 to June 30, 2009, the current in the surface layer was predominantly directed along the coast to the southwest, but there were also occurrences of opposite flow and less currents were observed toward other directions. In deeper layers, the current was predominantly directed along the slope either to the northeast (most frequent direction) or southwest.

Measurements in the open part of the Gulf of Finland also confirmed that the flow in the surface layer is predominantly along the gulf, and in the Estonian part of the gulf it is predominantly inward flow to the gulf. At the same time, all directions are represented with comparatively great frequency showing great variability of the currents and their dependence on meteorological conditions. In deeper layers, the currents are directed along the deepest part of the sea, as the predominant directions are dependent on the topography of the seabed. At station M2, currents in the bottom layer were directed towards the west or east, with an almost equal probability during the period of December 21, 2011to May 09, 2012. Four meters above the seabed, inflow into the gulf was slightly predominant (current directed to the east). In general, the measurements and modeling results are very compatible. However, as seen from a comparison of Figure 5–7 (lower panel) and Figure 5–10 (lower panel), the near seabed current speed in the deeper part of the pipeline route is slightly higher in the measurements than that in the modeling results.

5.1.6 Ice conditions

Ice conditions in the Baltic Sea may vary very much from year to year. The quantity of ice is basically determined by the severity of the winter, which in turn depends on atmospheric circulation. If the air flow from the west, carrying the warmer and more humid air from the North Atlantic to the Baltic Sea region, is stronger, the winter will be milder as well. The severity of winters based on the area of ice cover has been defined by Seinä and Palosuo (*Seinä and Palosuo 1996*). Unlike in average or severe winters, in mild winters there is very little or no ice in the area of the gas pipeline route. The year-to-year variability in the extent of the ice cover in the Baltic Sea is high. Over the past five years, for example, there has been mild (2013/2014), average (2011/2012) and severe winters (2010/2011).

Apart from the severity of a winter, local ice conditions also depend on other variables, such as the wind patterns or the quantity of precipitation. The figure (Figure 5–11) published in Ove Pärn's doctoral thesis (*Pärn 2011*) shows ice situations under various hydrometeorological conditions in the Gulf of Finland in 2003. The series of satellite images shown in the figure characterize well the dynamism of ice conditions in the Gulf of Finland. The ice-free area at the Finnish (A) and Estonian (B) coasts, respectively, may be seen in the two top panels. Presumably, both are instances of ice drift induced by the wind. Whereas ice is pushed away at one coast, shipping traffic is impeded due to stresses created in the ice at the opposite coast. Growth in wind-induced ice compression and ice deformation causes difficulties for ship traffic and damage to ships' hulls (*Pärn 2011*). Several irregularly distributed ice-free areas both at the Finnish and Estonian coasts may be seen in Panel C, whereas the entire gulf is relatively uniformly covered by ice in Panel D.

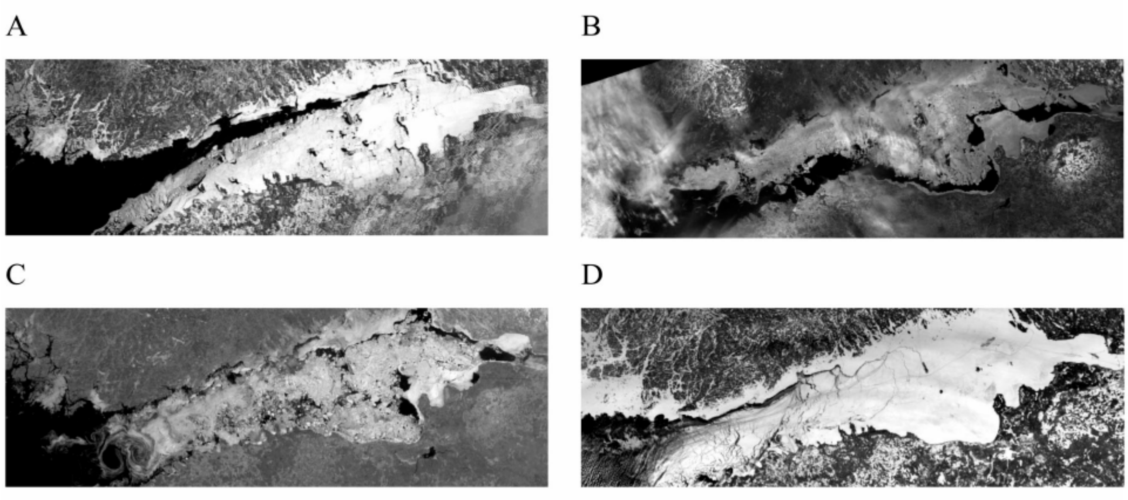


Figure 5-11. Ice situations in the Gulf of Finland (*Pärn 2011*): (A) lead at the northern coast of the gulf, (B) lead at the southern coast of the gulf, (C) irregular openings in the ice cover, and (D) relatively uniform ice cover.

Due to the southwesterly winds dominating the region, leads occur more frequently at the southern coast of the Gulf of Finland, with ice cover occurring there less frequently as a result. Pärn (2011) has estimated the average duration of the occurrence of the ice cover in the Gulf for a grid of 30 * 12 nautical miles (zonal and meridional dimensions of a grid cell, respectively). The average duration of the ice cover has been estimated to be 26 days in the Pakri Peninsula area, but 63 days at the same longitude at the Finnish coast (Pärn 2011). Pärn (Pärn 2011) has estimated the averages for severe winters to be 50 and 103 days, respectively.

At the coast, the ice period may be somewhat longer. For instance, Jaagus (*Jaagus 2005*) has estimated the average duration of the ice cover to be 48 days based on coastal observations at the Pakri Peninsula.

In the Gulf of Finland, the typical thickness of the ice crust is 30–40 cm, but may increase to 90 cm under certain conditions (*Seinä and Peltola 1991*). Under ridged ice conditions, ice may become deposited in piles over 10 m high (*Leppäranta and Hakala 1992*). At the coast, ridged ice may cause significant coastal processes, particularly under the conditions of high sea level or storms.

5.1.7 Hydrology and water quality

5.1.7.1 Temperature and salinity

The temperature regime of the Gulf of Finland is characterized by seasonal variability (especially in the surface layer) and strong vertical stratification in the summer months. In winter, the surface water cools below 0 °C and the ice forms. Maximum temperature occurs by the end of July or in August, when the temperature can be higher than 20 °C. The presence of horizontal and vertical gradients is characteristic for salinity distribution in the Gulf of Finland. The surface layer is fresher than the deep layers, and a quasi-permanent halocline with strong vertical salinity gradient exists at depths of 60–80 m. Due to the strong fresh water inflow at the eastern end of the Gulf of Finland gulf, the eastern part of the gulf is fresher than the western part, which is directly connected to the Baltic Proper (*Alenius 1998*).

On the basis of CTD data collected in the region, the average temperature of the sea surface layer in summer months is 15.2 °C (in July-August 16.9 °C), and the average salinity is 5.2 g/kg (*Liblik & Lips 2011*). The seasonal thermocline exists on average at depths of 12.8–27.2 m, where the vertical gradient of temperature is -0.99 °C/m and related vertical gradient of salinity is (on average) 0.09 (g/kg)/m. Below the thermocline, a cold intermediate layer exists with the average depth of the coldest water at 42 m and its temperature at 2.5 °C. The halocline, where salinity and temperature increase with the depth, is on average located at a depth of 64 m (the depth of the maximum salinity gradient). The temperature and salinity values at a depth of 70 m were respectively 3.9–5.0 °C and 9.1–9.8 g/kg (*Liblik & Lips 2011*).

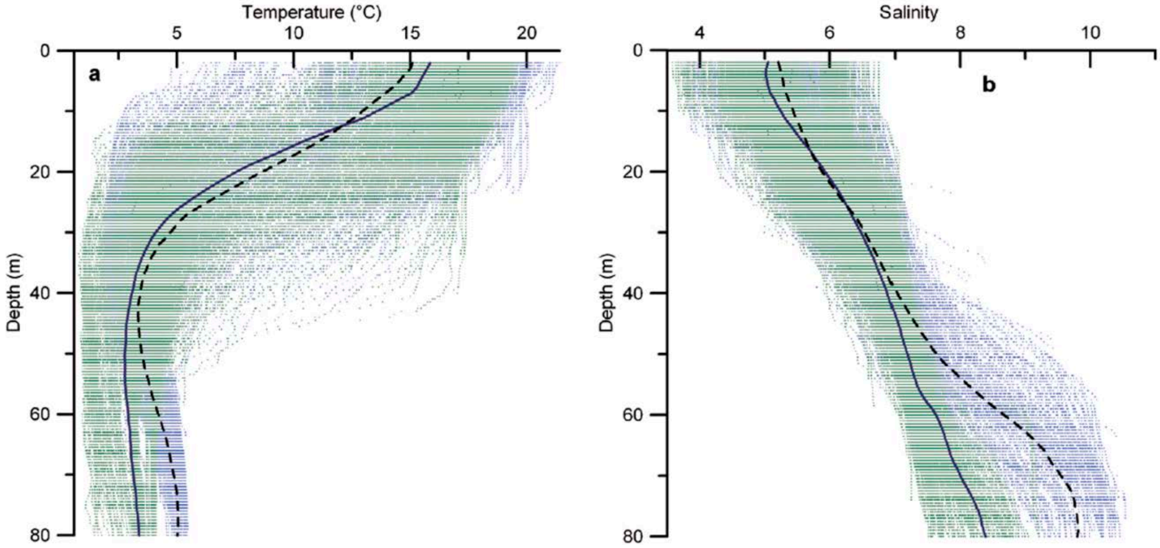


Figure 5–12. Vertical profiles of temperature and salinity in June-August 1987–2008 in the western part of the Gulf of Finland (mostly Estonian waters; between the longitudes 23.2 and 25.2°E. Solid line indicates an average profile before 1996 and dashed line average profile after 1996 (until 2008). (*Liblik & Lips 2011*)

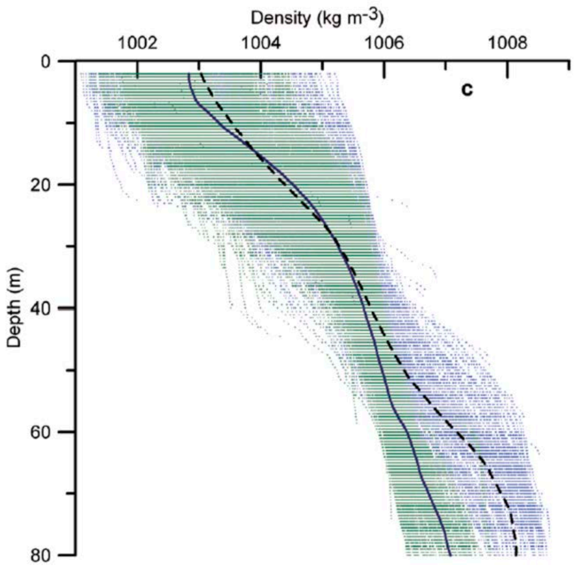


Figure 5–13. Vertical profiles of density in June-August 1987–2008 in the western part of the Gulf of Finland (mostly Estonian waters; between the longitudes 23.2 and 25.2°E. Solid line indicates an average profile before 1996 and dashed line average profile after 1996 (until 2008). (*Liblik & Lips 2011*).

The average vertical profiles of temperature, salinity and density, as well as their variability, can be seen in Figure 5–12 and Figure 5–13. After the strengthening of the halocline in mid-1990s, the vertical density distribution clearly reveals a 3-layer structure in summer, with strong seasonal thermocline and quasi-permanent halocline. An average difference between the deep layer (70 m) and surface layer density in this period was 4.8 kg/m³ (*Liblik & Lips 2011*).

Mapping of temperature and salinity distributions in the area of planned construction was conducted on July 3–4, 2013 (location of stations is shown in Figure 5–14). The horizontal distribution of temperature and salinity along the planned pipeline route corresponded to an average structure (Figure 5–15).

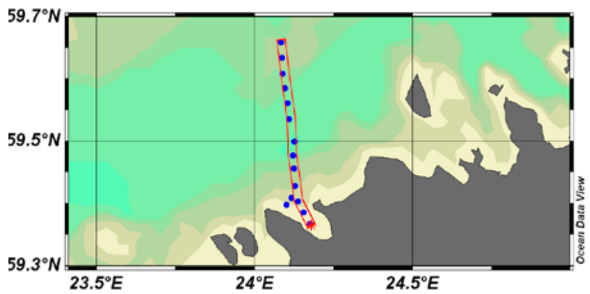


Figure 5–14. Location of stations along the planned pipeline route on July 3–4, 2013.

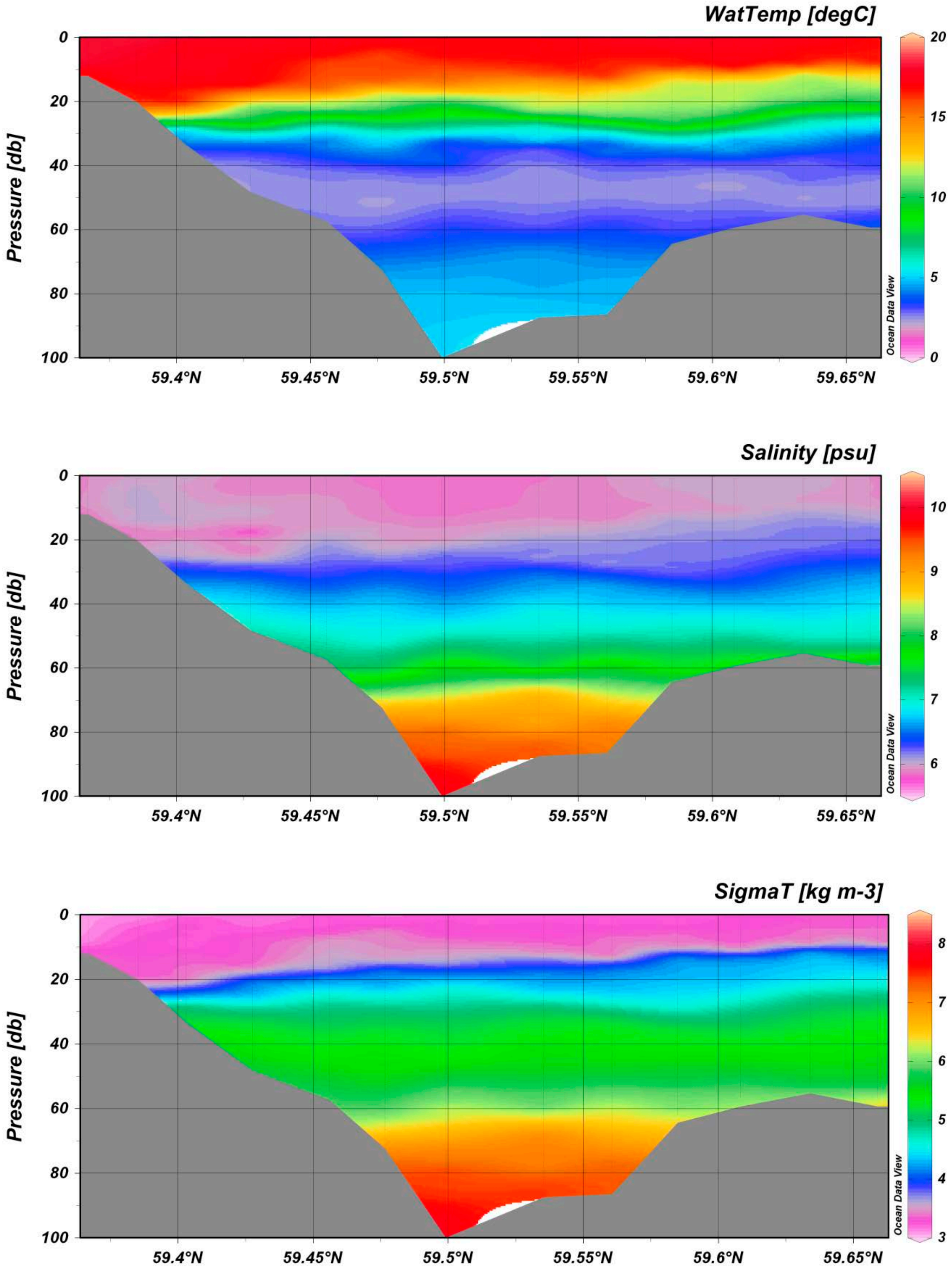


Figure 5-15. Vertical sections of temperature, salinity and density along the route of the planned pipeline in Estonian waters on July 3–4, 2013 (location of stations is shown in Figure 5-14).

The water column had a characteristic 3-layer structure in the area at the time of measurements in July 2013 – an upper warm layer with a temperature up to 18.1 °C, a cold intermediate layer with a minimum temperature at depths of 45–50 m and saltier near-bottom water layer existed. The water layers mentioned were separated by the seasonal thermocline at depths of 15–20 m and halocline at depths of 65–70 m. The observed inclination of the thermocline and horizontal distribution of salinity indicate that a more saline water flow was present along the Estonian shore. The density difference observed between the deep and surface layer was relatively large – up to 4.0 kg/m^{-3}.

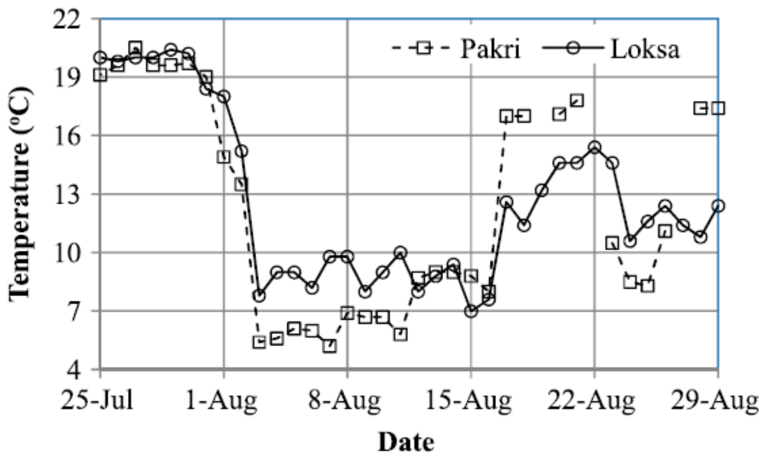


Figure 5–16. Temporal variability of temperature in the coastal stations of the Estonian Meteorological and Hydrological Institute (at present Weather Service) Pakri and Loksa in July-August 2006 (*Lips 2009*).

Stratification restricts the vertical exchange of substances between the surface and deep layers in summer. However, the water column is almost fully mixed from the surface to a depth of 60 m during the fall-winter convection, leading also to substantial transport substances (including nutrients) to the surface layer. In summer, occasional upwelling events, seen as a rapid drop in water temperature in the surface layer (see for instance Figure 5–16), can cause vertical transport of nutrients into the euphotic layer. These events can transport phosphorus to the euphotic layer in amounts comparable to the monthly input of phosphorus into the entire gulf from all rivers (*Lips 2009*).

5.1.7.2 Water quality

A system for assessing water quality in the coastal waters of Estonia has been adopted by a decree of Minister of the Environment (No 44, 28.07.2009; publishing record RT 2009, 64, 941). According to Annex 6 (updated in 2010) of this decree, the ecological quality of coastal waters is assessed using biological quality elements – phytoplankton, phytobenthos and zoobenthos and physical-chemical quality characteristics – concentration of total nitrogen and total phosphorus and water transparency (*Secchi depth*). The ecological quality of coastal waters in the region (Pakri Bay region, including also Lahepere Bay; by applying criteria as defined for the western Gulf of Finland coastal waters) has been assessed as having "moderate" quality on the basis of monitoring data from 2011 (*TU Estonian Marine Institute 2012*). Phytoplankton, phytobenthos and total nitrogen data gave "moderate" and zoobenthos, total phosphorus and *Secchi depth* data "good" ecological status (see Table 5–3).

Table 5-3. Results of the assessment of ecological quality of the coastal waters in the Pakri Bay region on the basis of monitoring data from 2011 (*TÜ Eesti Mereinstituut 2012*).

Assessment of ecological quality of coastal waters							
Water body: Pakri Bay	**Coastal water type III: western Gulf of Finland**						
Phytoplankton	Reference	Unit	Impact	Status	EQR	Quality Class	
Chlorophyll a	1.8	**μg/l**	+	3.4	0.586		
Phytoplankton biomass	0.28	mg/l	+	0.59	0.537		
						0.562	**Moderate**
Phytobenthos	Reference	Unit	Impact	Status	EQR		
Depth of penetration	15.0	m	-	8.2	0.547		
Fucus depth of penetration	7.0	m	-	1.6	0.229		
Proportion of perennial sp.	90.0	%	-	25	0.273		
						0.350	**Moderate**
Zoobenthos	Reference	Unit	Impact	Status	EQR		
ZKI	1.00		-	0.43	0.433		
FDI	1.00		-	0.59	0.592		
KPI	1.00		-	0.73	0.733		
						0.585	**Good**
Ecological status							**Moderate**
Physical-chemical parameters	Reference	Unit	Impact	Status	EQR		
Total nitrogen	15.3	**μmol/l**	+	23.4	0.661		Moderate
Total phosphorus	0.47	**μmol/l**	+	0.64	0.740		Good
Secchi depth	6.0	m	-	4.9	0.819		Good

ZKI, FDI and KPI are indexes characterizing the zoobenthos community structure in soft-bottom, phytobenthos zone and hard bottom conditions respectively. Impact signs „+“ or „-“ indicate how the human pressure influences the indicator value („+“ means that the value will increase in the case of impact and „-“ means that the value will decrease in the case of impact); EQR – ecological quality ratio (ratio between the measured value and water quality criteria) calculated according to Decree of the MoE No 44, July 28, 2009.

The criteria for open sea areas of the Gulf of Finland are not officially established in Estonia. Assessments have been conducted within the framework of HELCOM cooperation based on HELCOM core indicators and related limit values for good environmental status in the open Gulf of Finland. In the most recent assessment report, the following indicators were used: dissolved inorganic nitrogen and phosphorus concentration in winter, chlorophyll *a* content in summer, *Secchi depth* in summer and oxygen concentration in the water layer below the halocline (annual average). The assessment results based on single indicators were generalized using assessment tool HEAT 3.0, and the overall conclusion was that the environmental status of the Gulf of Finalnd is not good "non-GES" (GES means good environmental status; *HELCOM 2014*).

The status of open sea waters in the western Gulf of Finland has also been assessed as "non-GES", when using all available monitoring and research data from the region and applying HELCOM indicators and the HEAT 3.0 tool (*Stoicescu 2014*). If using a five-class system (as in HELCOM HEAT 3.0 and Estonian quality classification system for coastal waters – very good, good, moderate, poor and bad), the data from 2011–2013 indicated that the status was poor on the basis of winter nutrient concentrations, bad on the basis of summer chlorophyll *a* content, and moderate on the basis of *Secchi depth* and oxygen concentrations. Monitoring data from the two closest sampling points along the ferry line Tallinn-Stockholm (TS13 and TS14) in 2011–2013 gave an average total phosphorus concentration of 1.00 μmol/l and total nitrogen concentration of 19.1 μmol/l (data from: *Eesti Riiklik Keskkonnaseireprogramm 2014*). These results correspond to moderate water quality class on the basis of phosphorus data and very good water quality class on the basis of nitrogen data. These results show that, depending on the data set used (parameters and time period), the environmental status of waters in the region can be classified quite differently. First of all, this result points to the high natural variability in the region.

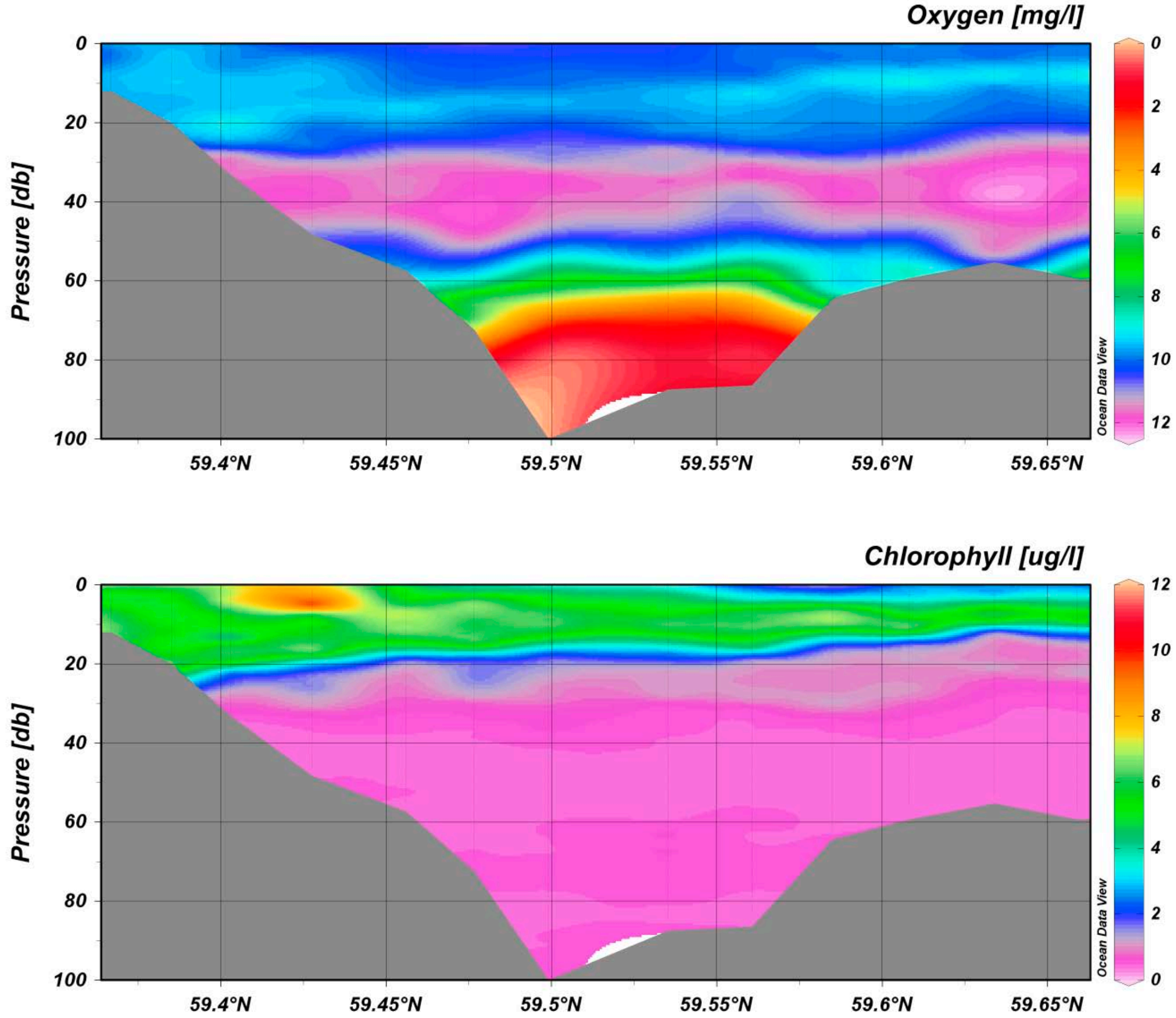


Figure 5-17. Vertical distributions of dissolved oxygen and chlorophyll a content along the route of the planned pipeline in Estonian waters on July 3–4, 2013 (location of stations is shown in Figure 5–14).

The vertical distribution of oxygen concentrations measured in July 2013 along the planned pipeline route revealed oxygen deficiency in the deep area, where below a depth of 65 m, the oxygen content was below 2 mg/l. At the same time, relatively high chlorophyll *a* concentrations were measured in the Estonian coastal sea areas (Figure 5–17).

Relatively poor oxygen conditions have been observed in the entire deep area of the Gulf of Finland according to the monitoring data from spring and summer 2014 (*TTÜ Meresüsteemide Instiuut 2014*). In anoxic conditions phosphorus is released from the bottom sediments (this is known as internal phosphorus loading) and in the border layer of oxic and anoxic waters, a zone with high water turbidity can occur. This phenomenon was also observed during a study related to the impact of construction of the Nord Stream pipeline in 2011 (*TTÜ Meresüsteemide Instiuut 2014; TÜ Eesti Mereinstituut 2011*). While the strong currents caused an increase inwater turbidity up to 8 NTU at a depth of 7 m above the seabed, due to the anoxic conditions and associated biogeochemical processes water turbidity could increase up to a value of 20 NTU (Figure 5–18).

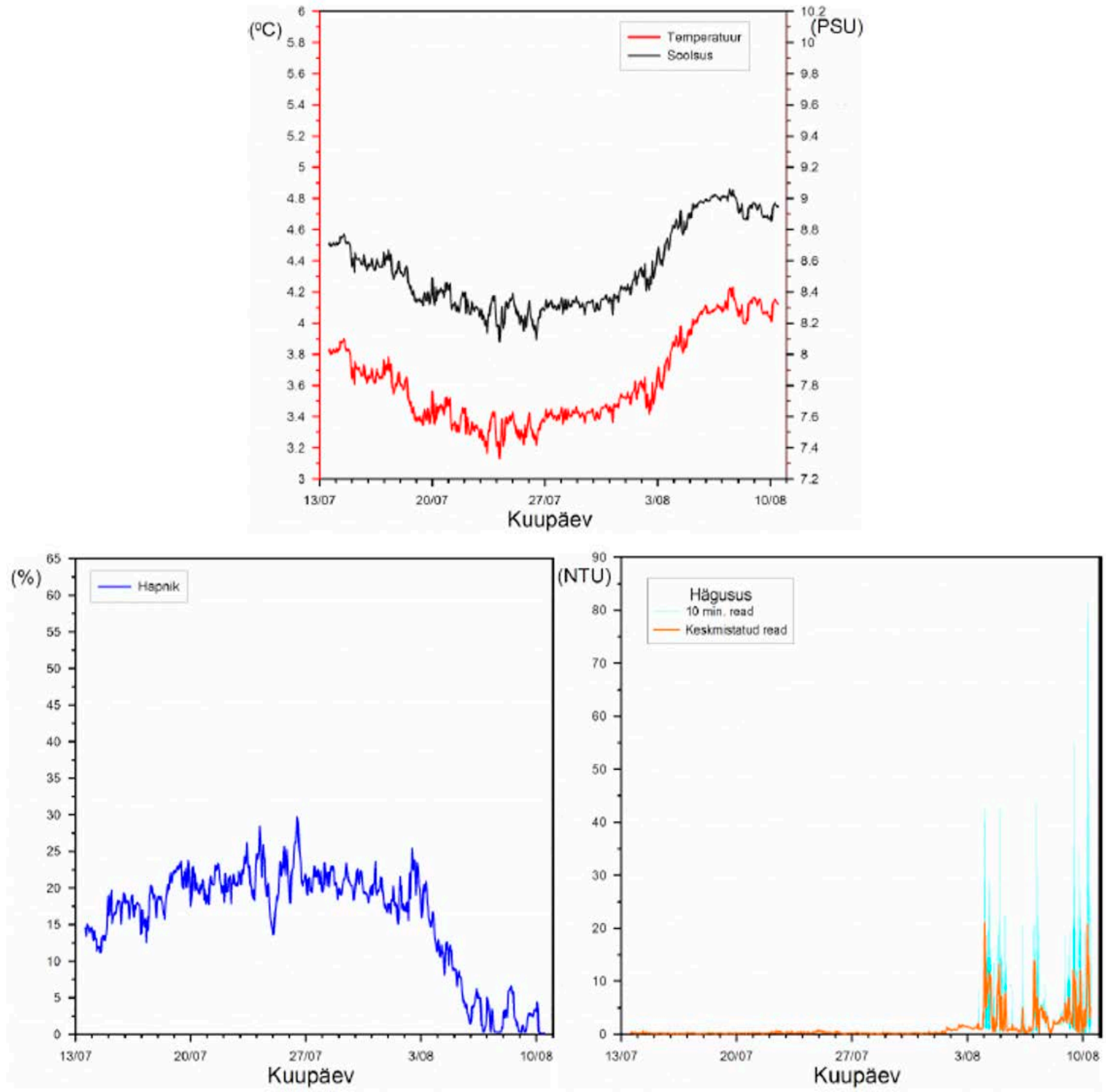


Figure 5–18. Temporal variations of temperature, salinity, dissolved oxygen content and water turbidity in the Gulf of Finland at a position of 59° 50,345′ N and 24° 49,812′ E in the period July 13,-August 10, 2011 (*TTÜ Meresüsteemide Instiuut 2014; TÜ Eesti Mereinstituut 2011*).

5.1.8 Benthic flora and fauna

Macrophytes form zones extending down to a maximum of around 20 meters from the surface of the sea. The strongest environmental factor affecting this zonation is the exposure of the shore, i.e. the direction of the shore in relation to the prevailing winds. The zonation of algae naturally extends deeper on open shores.

Depending on the species, macrophytes and zoobenthos found on them are characterized by major seasonal variation or permanence. Some species are perennial and occur in the same locations year after year, while some only occur at a specific time of the year, such as the summer or mid-winter from a couple of weeks to a few months. As a general rule, the zoobenthic species composition of the littoral zone is determined on the basis of the presence of algal species. The biggest threats faced by macrophytes and the zoobenthos associated with them are the overall marine eutrophication and its impacts including the decreased depth of visibility, which restricts light penetration in the littoral zone.

A downward trend has been observed in the species number of soft-bottom zoobenthos in the Northern Baltic Sea and the Gulf of Finland since the early 1900s. On the other hand, biomass growth has been observed in places (*Perus & Bonsdorff 2004).* Another change in zoobenthos currently underway is a shift in the relative proportions of their functional groups. Groups feeding on benthic organic matter have increased at the expense of those filter-feeding in the water column (*Bonsdorff & Blomqvist 1993*): benthic feeders include the red-gilled mud worm (*Marenzelleria viridis*) and water column filter feeders include the Baltic macoma (*Macoma balthica*). These trends lead into a loss of zoobenthic diversity, with fewer species occurring and with those that do occur gaining larger relative proportions. The primary although not the only reason for the changes in the number of species and the functional groups is the overall eutrophication taking place in the marine area (*Perus & Bonsdorff* 2004). Eutrophication leads into local oxygen depletion in deep basins where the turnover of water is usually very low due to stratification caused by the thermocline and halocline. Tolerance of temporary oxygen deficiency varies between groups of animals. *Bivalves* can tolerate the longest periods of anoxia, but even they will die if the anoxia persists for a few weeks. Oxygen depletion results in seafloor desertification.

Description of the benthos in Lahepere Bay is done by using the inventory data of the benthic fauna and habitats collected in Lahepere Bay as part of the SEA for the thematic plan for the Paldiski LNG terminal in 2009 (*TÜ EMI 2009*) and data from the marine environmental study performed in conjunction with the construction of the Balticconnector gas pipeline (*TTÜ Mereuuringute Instituut 2013*).

In 2009, the benthos was observed visually and samples were collected across the entire Lahepere Bay at depths of 0.5–30 m. Quantitative samples were collected from a total of 40 stations. The seabed was documented by underwater camera from 120 stations.

In 2013, samples of zoobenthos were collected at 15 stations along the transect of the proposed gas pipeline, from Lahepere Bay to the Estonian exclusive economic zone. In the study area, depth ranged 12–101 m. Samples of phytobenthos were collected from four transects located at the landfalls of the gas pipeline (ALT EST 1 and ALT EST 2) and in their vicinity, at depths ranging 0.5–8 m. For a more detailed analysis of the phytobenthos, underwater videos were also made of all four transects.

The quantitative samples collected in either year were analyzed at a laboratory, determining the species composition and biomass of the phyto- and zoobenthos. The abundance of zoobenthos was determined in 2013. The study of benthos was performed under international HELCOM COMBINE methodology.

5.1.8.1 Phytobenthos

Lahepere Bay had diverse phytobenthic communities. A total of 22 species of the phytobenthos were recorded in 2009, and 20 species in 2013. In 2013, three species of green algae, seven species of brown seaweed, four species of red seaweed, one species of *Chara aspera* and five species of higher plants were found. The species composition of the phytobenthos varied greatly in the studied area, depending mainly on the bottom type and on the depth.

Red seaweed (*Ceramium tenuicorne*) had the greatest distribution in Lahepere Bay, with a rate of 80% in the samples. In the area of observation, the species occurred in the depth rangeof 0.5–14 metres. Other species occurring in the study area were red seaweed (*Polysiphonia fucoides*), green algae (*Cladophora glomerata*), and brown seaweeds (*Chorda filum* and *Pylaiella littoralis*).

The seabed in the ALT EST 2 at Pakrineeme landfall is characterized by heterogeneity. At a depth of 6 m, the predominant bottom type is sand and gravel. There, on small stones or in loose mats red seaweeds such as *Furcellaria lumbricalis*, *C. tenuicorne* and *P. fucoides* occurred. In the shallow near-shore area, the bottom substratum is formed by limestone and stones. The species composition of the benthic flora there was more diverse, with a total coverage as high as 90%. The key species on the hard bottom were *Fucus vesiculosus*, with a coverage up to 40%, and *P. fucoides*, with a coverage up 60%. Red seaweed *C. tenuicorne* (15%) and brown seaweed *P. littoralis* (10%) occurred less frequently. In the shallowest sea, high coverage of green algae *Cladophora glomerata* (50%) and brown seaweed *C. filum* (20%) was observed. In 2009, phytobenthos was recorded to a depth of 26 m in Lahepere Bay at ALT EST 2.

Figure 5-19. Phytobenthos in the ALT EST 2 area, at depths of 0.5–1 m.

In the shallow southern part of Lahepere Bay, ALT EST 1, the dominant bottom sediment is sand. This area is characterized by diverse soft-bottom phytobenthic communities with high variation in species composition. The key species were higher plants – fennel pondweed (*Stuckenia pectinata*) and horned pondweed (*Zannichellia palustris*), *C. tenuicorne* and *P. littoralis* occured as epiphytes on higher plants. In places, coverage of fennel pondweed reached 70%. At depths of 1–1.5 m, meadows of eelgrass (*Zostera marina*) around 4 m wide occurred as well. In places, dry biomass for eelgrass reached 101.9 g/m². Rocks found on the soft bottom were covered by *P. fucoides*, *C. tenuicorne* and . *littoralis*. In the shallow coastal zone, *Chara baltica*, green algae *C. glomerata* and *Ulva intestinalis*, and brown seaweed *Dictyosiphon foeniculaceus* also occurred. In places, *C. filum* was growing. At a depth of 0.5 m, *C. baltica* occurred with greater coverage and biomass, 25% and 20.6 g/m² respectively.

Figure 5-20. Eelgrass (*Zostera marina*) in the area of ALT EST 1 at a depth of 1 m.

5.1.8.2 Benthic fauna

The sediment type varied in the area studied. Sand with minor contribution from gravel prevailed in shallow stations in the Lahepere Bay. The clay and mud content increased in the bottom deposits with increasing depth and became clearly dominant bottom material in the area deeper than 40 m.

In the Pakrineeme landfall area, the bottom is predominantly rocky.

A total of 32 species of benthic fauna were identified in the studied area. No zoobenthos was found at the deepest stations (86–101 m) with a lack of oxygen. The species composition of the communities was poor at stations deeper and further from the coast outside Lahepere Bay and in the central part of the Gulf of Finland. In these communities, the number of species was 2–4. In deeper areas with soft and fine-grained bottom sediment, the main benthic fauna community consisted of Baltic macoma (*Macoma balthica*), *Halicryptus spinulosus* and *Marenzelleri neglecta*. Baltic macoma was a key species on soft bottoms in the area studied, occurring across the widest depth range in the area and dominated other species in terms of its abundance and biomass. In places, mainly in the mouth of Lahepere Bay, also *Monoporeia affinis* occurred in high numbers. Outside the phytobenthic zone, at depths of 12–21 m in areas with a soft bottom, the key species were Baltic macoma, blue mussel (*Mytilus trossulus*),

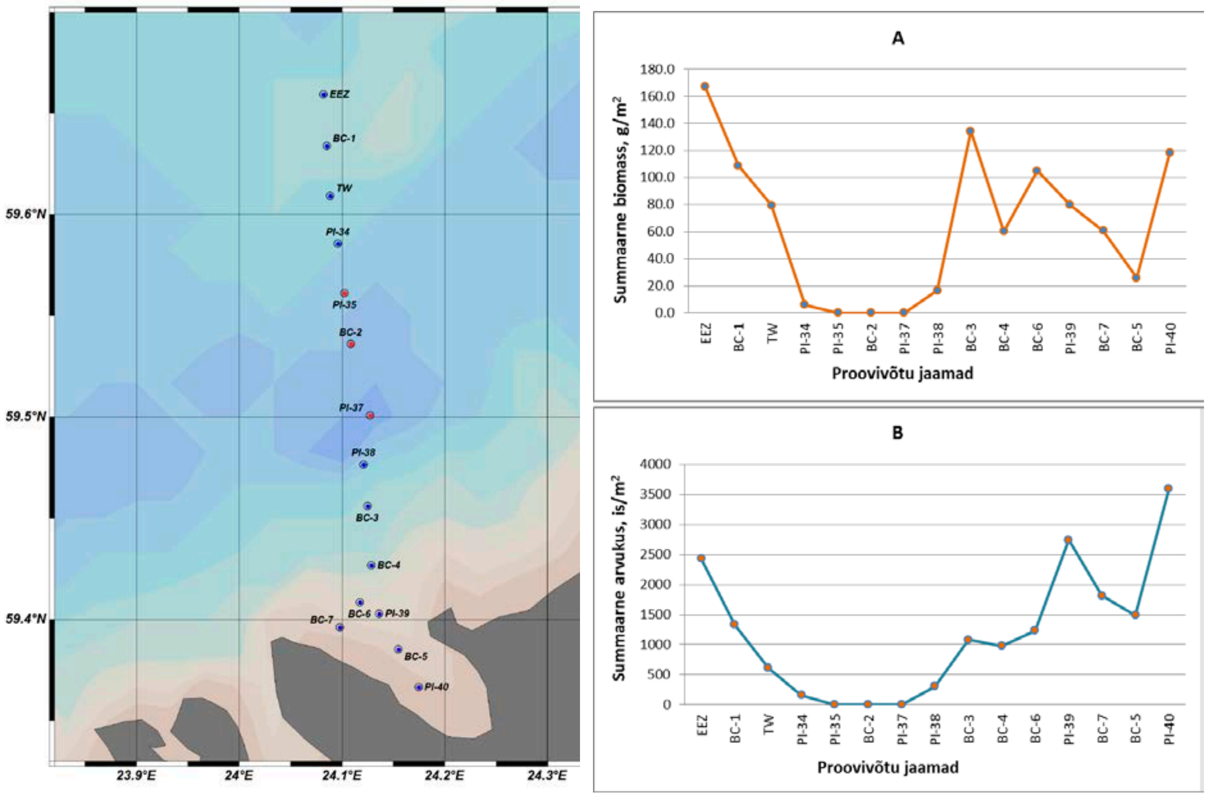


Figure 5-21. Sampling stations for benthic fauna in 2013 (stations with no benthic fauna are marked in red) and benthic macrofauna total biomass (A) and abundance (B) at the studied sampling stations.

H. spinulosus, *M. affinis* and *Oligochaeta*. To a lesser extent, there occurred snails: laver spire shell (*Peringia ulvae*), spire snail (*Ecrobia ventrosa*) and New Zealand mudsnail (*Potamopyrgus antipodarum*).

The key species in the community on rocky bottoms were blue mussel and bay barnacle (*Amphibalanus improvisus*). On hard bottoms, blue mussel was the species with the greatest coverage, abundance and biomass, also occurring to a larger extent in the ALT EST 2 area.

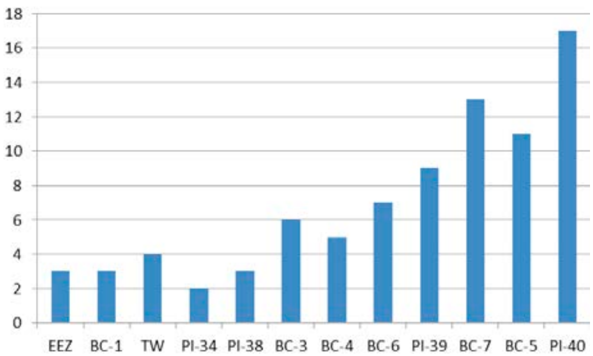


Figure 5–22. Number of benthic fauna species at the sampling stations studied in 2013, excludes stations without any benthic fauna.

The communities of benthic fauna in the phytobenthic zone were the richest in species. Also there occurred species in whose life processes phytobenthos plays an important role, offering shelter and food. These were *Gammarus* spp. (*G. salinus*, *G. oceanicus*), isopods *Idotea* spp. (*I. balthica*, *I. chelipes*) and snails: *Radix perega*, river nerite (*Theodoxus fluviatilis*) and Laver spire shell.

On the rocky bottoms in the ALT EST 2, the dominant species were blue mussel and bay barnacle. In the area of the landfall of ALT EST 1, the dominant bottom substratum was sand, where river nerite, laver spire shell, baltic isopod (*Idotea balthica*) and *Idotea chelipes* prevailed. In terms of bivalve molluscs, blue mussels, forming little knots by attaching to one another, and also Baltic macoma, burrowing in the sand, dominated.

5.1.9 Plankton

Plankton is a diverse group of organisms living in the water column and moving with currents. This group includes small animals, protists, bacteria, archaebacteria and viruses living in the water column in the pelagic regions of the sea. Most plankton species are microscopic. This report addresses the seasonal dynamics of phytoplankton and zooplankton in the impact area near the Estonian coast.

This summary has been prepared based on the annual national marine monitoring materials about the Gulf of Finland from the Estonian Marine Institute, University of Tartu, and the Marine Systems Institute, Tallinn University of Technology. Since Lahepere Bay is an open bay, and there is an unhindered exchange of water with the Gulf of Finland, its plankton community does not generally differ from the plankton in the Gulf of Finland near this area.

5.1.9.1 Phytoplankton

The species composition, biomass and numbers of the phytoplankton in the Gulf of Finland vary during the year. The changes are due to seasonal changes in the temperature, nutrients patterns and light conditions in the Baltic Sea. The phytoplankton is poorest in specimens and species in winter, when algae growth is constrained by a lack of light. In winter, cold-water species of diatoms and dinoflagellates dominate in the phytoplankton community.

In spring, mostly in later March / early April, the quantity of phytoplankton begins to increase dramatically (Figure 5–23). Mass growth of microscopic algae – spring bloom – develops due to the high inorganic nutrient concentration in the water and development of stratification in the water column caused by the intensification of solar radiation. The spring phytoplankton is dominated by diatom and dinoflagellates. The spring bloom ends upon exhaustion of nutrients in the upper mixed layer around mid-May. The spring growth of microscopic algae is followed by the minimum levels of phytoplankton in early June. The community of this period is dominated by small-size and heterotrophic algae.

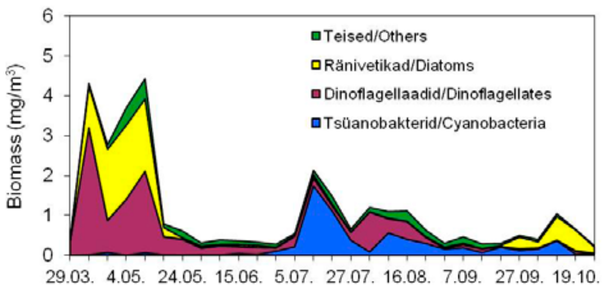


Figure 5–23. Seasonal phytoplankton patterns in the Gulf of Finland.

In summer, when the water temperature rises over a certain threshold, the Baltic Sea plankton is dominated by cyanobacteria, which in the event of the confluence of certain conditions may produce extensive blooms also in the Gulf of Finland. In the summer plankton, high numbers of dinoflagellates (*Heterocapsa triqietra*, *Dinophysis acuminata* etc) and haptophytes (*Chryschromulina* spp) may occur.

The water temperature in autumn drops and mixing within the water column intensifies, with the species composition of the phytoplankton changing along with it. In summer, the thermophilous species gaining a competitive advantage under the conditions of strong stratification in the water column are replaced by cold-water species with a greater tolerance for mixing. In autumn, a diatom bloom may occur; however, it is always well below the intensity of the spring bloom. Subsequently, as water is mixed by convection and solar radiation decreases, the abundance and biomass of the phytoplankton drop to the level of the winter minimum.

The plankton communities in the area of the proposed Balticconnector gas pipeline may be characterized by data collected at Estonia's offshore monitoring stations PE, 19 and TS13 (Figure 5–24).

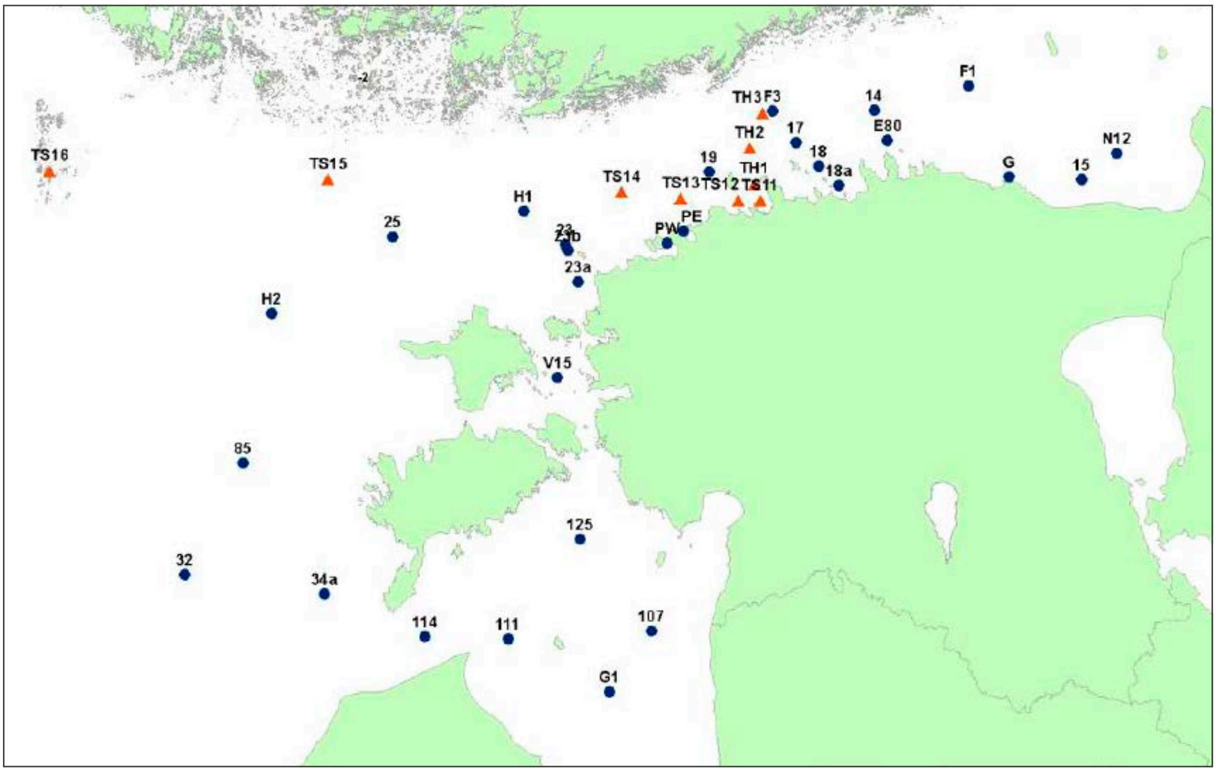
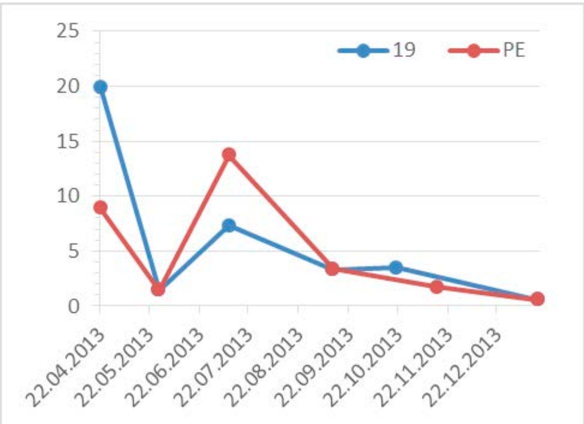


Figure 5–24. Location of offshore monitoring (blued dots) and Ferrybox monitoring (red triangles) stations in the Gulf of Finland in 2013.

In the area of the proposed Balticconnector gas pipeline in spring 2013, values for phytoplankton chlorophyll *a* were determined within a range of 2.78–19.90 mg per l^{-1}, the usual concentration during the spring bloom period. In summer, the maximum values of chlorophyll *a* remained below 7 mg per m^{-3} in offshore areas in the area studied. At the same time, a concentration of chlorophyll *a* twice as high was recorded in Lahepere Bay in mid-July, showing the high spatial variability.



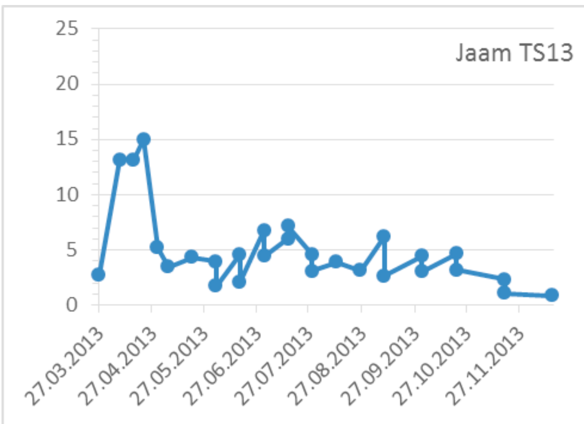


Figure 5–25 Concentrations of chlorophyll *a* at monitoring stations 19, PE and TS13 (*data from the data supplement to the 2013 offshore marine monitoring*).

Depending on the time of year, the species characteristic of the Gulf of Finland include diatoms: *Thalassiosira baltica, T. levanderi, Sceletonema marinoi*, *Pauliella taeniata*; dinoflagellates: *Scrippsiella* complex, *Peridiniella catenata, Heterocapsa triquetra*; cyanobacteria: *Aphanizomenon flos-aquae*, *Nodularia spumigena* and *Anabaena* spp; and an autotrophic species of *Ciliophora*: *Mesodinium rubrum*. Autumn blooms may be caused by diatom *Coscnodiscus granii*.

Figure 5–26 shows the monthly mean concentrations of chlorophyll *a* measured as part of monitoring the Gulf of Finland and phytoplankton biomass values in 2011–2013, which characterize the scale and timing of the summer bloom of the phytoplankton in various areas of the bay.

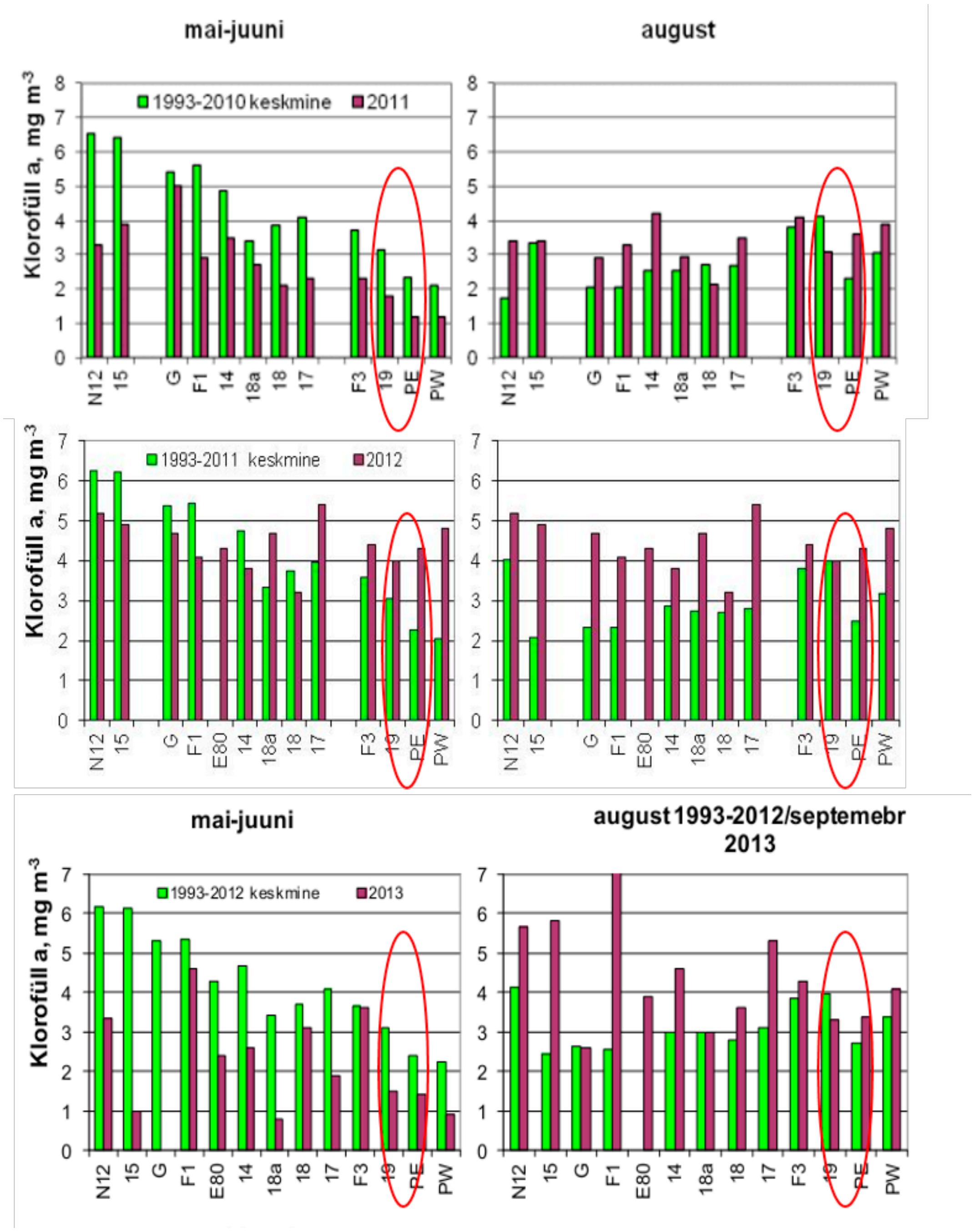


Figure 5–26. The mean concentration (mg per m^{-3}) of chlorophyll *a* in the seawater at monitoring stations in the Gulf of Finland in late May/early June and in August / September in 2011, 2012 and 2013 compared to the period from 1993. The relevant values for stations within the area of the installation of the gas pipeline are shown inside the red oval.

5.1.9.2 Zooplankton

In the Baltic Sea, the species composition of the zooplankton and the distribution of individual species primarily depend on salinity. In the south section of the sea, marine species of fauna prevail in the plankton, whereas in the more northerly areas their proportion declines and the proportion of brackish-water species increases as salinity decreases.

Like the phytoplankton, the zooplankton community is characterised by seasonal changes; however, these are not as dramatic or clear-cut as in case of the phytoplankton. The winter zooplankton is relatively poor in species or specimens and is comparatively evenly distributed vertically. Due to the increasing phytoplankton biomass, the spring zooplankton is richer than the winter one. Right after the spring maximum in the phytoplankton, *Ciliophora* develop on a massive scale. The numbers of *Ciliophora* are the higher, the richer is the phytoplankton in the relevant area. Such close dependency appears to be determined by the fact that dead phytoplankton supports the development of saprophytic bacteria that provide food for *Ciliophora*. As the water temperature rises, in May the rotifers reach their highest numbers. In the plankton community, copepods are represented by the same species as in winter and, since the pool of food (phytoplankton, *Ciliophora* and bacteria) is abundant, copepods reproduce intensively. The summer zooplankton is characterised by a richness of species. In late summer, water contains high numbers of macroplankton, moon jellyfish. In autumn, the numbers of summer forms decreases and the proportion of cold-water species increases.

According to 2011–2013 monitoring data, the mean numbers of the zooplankton varied from 18,000 to 92,000 specimens per m^{-3}. Over three years, mean biomass varied from 0.2 to 0.6 g per m^{-3}. Whereas the 2011 and 2012 samples generally resembled earlier ones, the 2013 zooplankton density in the Gulf of Finland remained below the mean for the past 10 years in terms of both biomass and numbers.

In terms of their numbers, the dominant zooplankton species in the Gulf of Finland 2011–2013 were rotifers: *Keratella quadrata*, *Synchaeta baltica* and *S. monopus*; copepod *Eurytemora affinis*; larvae of bivalve molluscs (*Bivalvia*); and *nauplius larvae* of copepods. In terms of biomass, in addition to the above, the copepod *Pseudocalanus acuspes* and the cladoceran *Pleopsis polyphemoides* were also significant. In the summer samples, rotifer *K. quadrata*, copepod *E. affinis* and copepod larvae occurred in high numbers, with the cladoceran *Pleopsis polyphemoides*, in addition to the above, also having a high biomass.

In terms of species compositions, the stations in the Gulf of Finland did not differ much from each; however, to an extent, there could be observed the dependency of the density of some species according to the location of the stations along the salinity and temperature gradients. Species that have a more marine origin or are more cold-water, such as *Pseudocalanus acuspes, Temora longicornis, Centropages hamatus* and *Fritillaria borealis*, occurred only, or in greater numbers, in the western section of the Gulf of Finland.

5.1.10 Fish and fisheries

Fishing taking place along the pipeline route in the exclusive economic zones (EEZ) of Finland and Estonia was studied on the basis of the statistical rectangles of the International Council for the Exploration of the Sea (ICES). Statistics on catches were produced for the Estonian side concerning the area covered by ICES rectangles 47H4 and 48H4 (2011–2013) and for the Finnish side for the area covered by rectangles 48H4 and 48H3 (2010–2012) (*Ramboll 2013a, Ramboll 2013b,* Figure 5-27).

Fish fauna of the Gulf of Finland

The fish fauna of the offshore areas is described on the basis of existing studies. In autumn 2013 echo-sounding and test trawling were carried out in the Gulf of Finland by the Finnish Game and Fisheries Research Institute using the marine research vessel Aranda (*RKTL & SYKE 2013*). Corresponding monitoring has previously (2006–2012) been carried out in the Gulf of Finland in cooperation between Finland and Estonia (*ICES WGBIFS 2009; ICES WGBIFS 2010; ICES WGBIFS 2011*). A survey of the status of the fish stocks was conducted on the basis of studies including those mentioned above (*Raitaniemi & Manninen 2014*). Furthermore, pelagic fish stocks of the Gulf of Finland have been studied in research projects including the one carried out in 2002–2006 where areas around the Gulf of Finland were surveyed using echo-sounding and a pelagic research trawl to study the structure of the fish stocks and any differences between areas (*Peltonen 2006*). Research trawling also took place in conjunction with the Nord Stream gas pipeline project.

The fish stocks of the Gulf of Finland consist of marine and freshwater species. The low salinity of the Gulf of Finland area is a limiting factor for many marine species, which live at the extremity of their distribution area in this area. The fish stocks of the Gulf of Finland are also affected by any changes taking place in the fish stocks of the main basin of the Baltic Sea. The periods of oxygen depletion occurring in the deep basins also pose a challenge, limiting the habitats of demersal fish and zoobenthos.

The species of fish living in the offshore areas of the Gulf of Finland affected by the Balticconnector gas pipeline project can be divided into three groups: 1) pelagic schooling fish, 2) demersal fish and 3) migratory fish. The habitats, diets and migratory dynamics of each group differ from each other. In the texts below, 'offshore area' refers to the area without islands and deeper than 20 m stretching out after the outer archipelago of Finland.

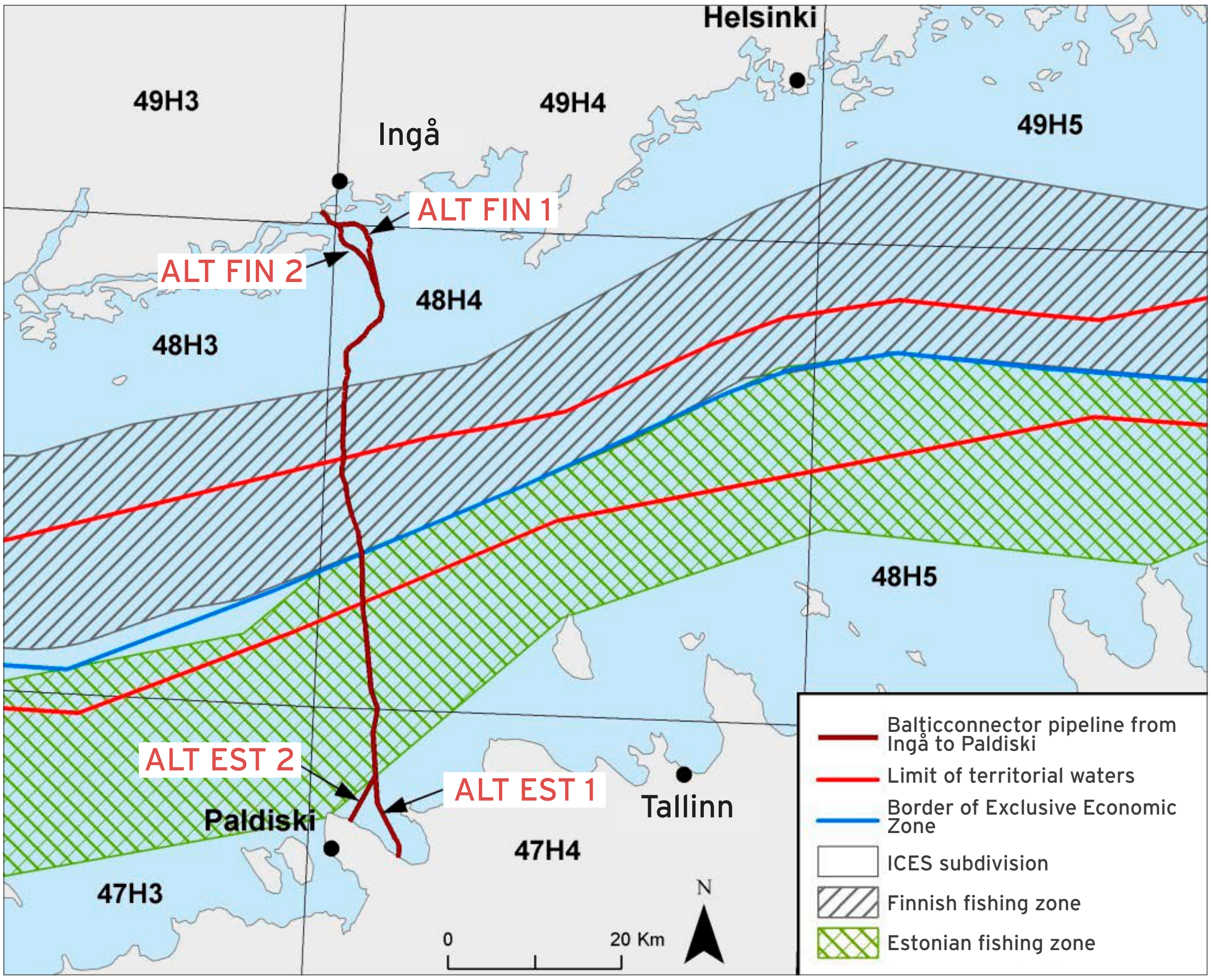


Figure 5-27. The Finnish and Estonian fishing zones and the ICES subdivisions in the project area.

Pelagic schooling fish

Pelagic schooling fish occurring in offshore areas include Baltic herring (*Clupea harengus membras*), sprat (*Sprattus sprattus*) and three-spined stickleback (*Gasterosteus aculeatus*) and, in smaller numbers, also ten-spined stickleback (*Pungitius pungitius*). According to Peltonen et al. (*Peltonen 2006*), the most common pelagic species in the offshore areas of the Gulf of Finland are Baltic herring, sprat and three-spined stickleback, the diet of all of which mainly consists of zooplankton. The share of other species in the offshore areas is small (*RKTL & SYKE 2013*). The Baltic herring and particularly sprat stocks of the Gulf of Finland are linked with the stocks found in the main basin of the Baltic Sea (*Raitaniemi & Manninen 2014* and *Aro 1989*). Sprat born in the main basin compete for food with the Baltic herring stocks of the Gulf of Finland when Baltic herring migrate to the main basin and, other the other hand, when sprat migrate to the Gulf of Finland. Therefore it would appear that the abundance of sprat has an impact on the growth of Baltic herring in the Gulf of Finland (*Peltonen 2006*). Major annual population variation is typical for Baltic herring and sprat. For example, the spawning stock of Baltic herring in the main basin of the Baltic Sea and the Gulf of Finland in 2013 was almost 90% larger than in 2000 but only roughly one-half of the 1974 level (*Raitaniemi & Manninen 2014*). Correspondingly, the spawning stock of sprat in the Baltic Sea in 2013 was around one-half of that of the record year seen in 1996 (*Raitaniemi & Manninen 2014*).

According to Peltonen et al. (*Peltonen 2006*) the depth of occurrence of fish is affected by the stratification of the Gulf of Finland. According to echo-sounding surveys, the density of fish was the highest close to the thermocline. Sprat and Baltic herring in particular avoided the warm surface layer and the cold (below 3 °C) deep areas even where no limiting factor role was played by oxygen levels. Three-spined stickleback, however, favor warmer water and also move in surface waters.

Sprat and Baltic herring differ from each other in terms of spawning. Baltic herring spawn on littoral vegetation mainly in the spring (May–June), while sprat spawn in the open water in the summer months and their pelagic eggs require a minimum salinity of 5–6‰. This limits the possible spawning areas of sprat in the Gulf of Finland to the western parts of the gulf. The primary spawning grounds of sprat are, however, located in the main basin of the Baltic Sea in the southern parts of the Bornholm and Gdańsk as well as Gotland Deeps (*Koli 1990*). Three- and ten-spined stickleback, on the other hand, spawn in the summer close to the shore as well as in the archipelago and coastal rivers.

Pelagic schooling fish play a major role in the food chain, being a food source for species such as salmon (*Salmo salar)* and brown trout (*Salmo trutta)*. Baltic herring and sprat are also economically highly significant species of fish for professional fishing in Estonia as well as Finland.

Demersal fish

Demersal species of fish found in the offshore areas of the Gulf of Finland include cod (*Gadus morhua*), lumpfish (*Cyclopterus lumpus*), short-horn sculpin (*Myoxocephalus scorpius*), longspined bullhead (*Taurulus bubalis*), fourhorn sculpin (*Myoxocephalus quadricornis),* snakeblenny (*Lumpenus lampretaeformis*), viviparous blenny (*Zoarces viviparus*) as well as the sand-bottom dwelling sandeels (*Hyperoplus lanceolatus, Ammodytes tobianus*), flounder (*Platichthys flesus*) and turbot (*Psetta maxima*). Most demersal species feed on zoobenthos, the occurrence of which in the deep bottoms of the Gulf of Finland is mainly limited to depths up to 70 m due to the poor oxygen situation.

Most demersal species spawn on the coast. An exception to this is cod which, like sprat, have pelagic eggs. The spawning grounds of cod are located at depths of 50–150 m in the southern parts of the Gotland Deep, the Bornholm Deep and Gdańsk Bay (*Koli 1990*). Because cod eggs need a minimum salinity of 10–11‰ for buoyancy as well as oxygen (more than 2 mg/l), the stratification of the Baltic Sea causes reproductive problems for cod. As a result of this, the status of cod stocks is poor.

Demersal fish play a role in the food chain. For example, viviparous blenny is an important part of the diet of many predatory fish species and aquatic birds, while fourhorn sculpin and lumpfish are items in the diet of cod. Economically significant demersal fish species include cod and flounder, particularly off the Estonian coast.

Migratory fish

The main migratory fish species occurring in the offshore areas of the Gulf of Finland are salmon (*Salmo salar*) and brown trout (*Salmo trutta*). Both salmon and brown trout spawn in rivers, from where their smolts migrate to the sea after the parr stage. It has been found in tagging research that salmon and brown trout of the Gulf of Finland remain mainly in the Gulf of Finland area during their feeding migration (*Mikkola 1995*). The most important items in the diet of salmon are Baltic herring and sprat, while brown trout feed closer to the coast and their main prey species are Baltic herring and sticklebacks. Salmon and brown trout are economically important species in the marine areas as well as for fishing in the spawning rivers.

Fishing in the Gulf of Finland

Professional fishing in the offshore areas of the Gulf of Finland consists almost exclusively of Baltic herring and sprat trawling. Trawling gear used includes pelagic and demersal trawls as well as their pair and single trawling variations depending on the method employed. Some salmon fishing also takes place, with longline fishing used as the technique (*Ramboll 2013a*). The use of driftnets, however, is now totally banned throughout the Baltic Sea.

Fishing quotas have been determined by the International Baltic Sea Fishery Commission (IBSFC) for sprat, Baltic herring, salmon and brown trout for the Baltic Sea, regulating issues including the trawling of Baltic herring and sprat. Baltic herring in the Gulf of Finland is regulated as sub-populations of the main basin populations of the Baltic Sea and of the Gulf of Finland. Correspondingly, sprat fishing is regulated on the basis of a quota covering the entire Baltic Sea, which in many years has also restricted the utilization of the Gulf of Finland Baltic herring quota.

There has been major annual variation between the percentages of catch of Baltic herring and sprat. For example, in the 2011–2013 period the trawling harvests have collapsed to around one-half. Trawling mainly takes place using pelagic and midwater trawls, which enables fishing in areas including those where the seabed is uneven. Demersal trawling was also reported in the project area, but the harvests from demersal trawling only accounted for 0–2% of the total (*Ramboll 2013a, Ramboll 2013b*). The offshore area located close to the project area can be regarded as a significant trawling area in the Gulf of Finland scope (*Nord Stream 2009*).

Table 5-4. Sprat and Baltic herring catches (tonnes) for statistical rectangles 48H3 and 48H4 in 2010–2012 (*Ramboll 2013a*).

Species	2010	2011	2012	Total	% of total
Sprat	6 507	5 311	3 957	**15 775**	58%
Baltic herring	3 182	4 674	3 753	**11 609**	42%
Total	**9 689**	**9 985**	**7 710**	**27 384**	**100%**

Table 5-5. Sprat, Baltic herring and smelt (*Osmerus eperlanus)* catches (tonnes) for statistical rectangles 48H4 and 47H4 in 2011–2013 (*Ramboll 2013b*).

Species	2011	2012	2013	Total	% of total
Sprat	7 257	6 056	3 473	**16 786**	77%
Baltic herring	2 131	1 738	1 123	**4 992**	23%
Smelt	2	0	0,7	**2,7**	0%
Total	**9 409**	**7 793**	**4 586**	**21 788**	**100%**

There are no protected areas in or close to the offshore section of the project area. Offshore fish stocks are, however, regulated on the basis of fishing quotas. The Baltic herring and sprat stocks are of very high significance to society, being the main catch target for trawlers on the Finnish as well as the Estonian side.

Fish and fisheries at Lahepere Bay

The fish community of Lahepere Bay (the abundance of fish and biodiversity of species) broadly speaking resembles the other areas surveyed in the western part of the Gulf of Finland and the northern coast of Hiiumaa. At the same time, the fish community is relatively species-rich – according to monitoring and professional fishery data, the bay may contain approximately 46 different species of fish, which is a large number compared to most of the sea areas surveyed in Estonia. As far as we know, the Baltic herring is the most significant fish species spawning in Lahepere Bay.

The condition of the fish spawns of Lahepere Bay was evaluated along the route of the planned pipeline and nearby. Survey catches/studies were conducted in 2009 (in April and June) and in 2013 (June 12 spawning grounds of the Baltic Herring; May 14 and August 20 seine fishing for the study of commercial juvenile fish and small-bodied fish species; August 20–22 survey of fish using series of gillnets). In addition, official fishery statistics have been taken into account in drafting the summary.

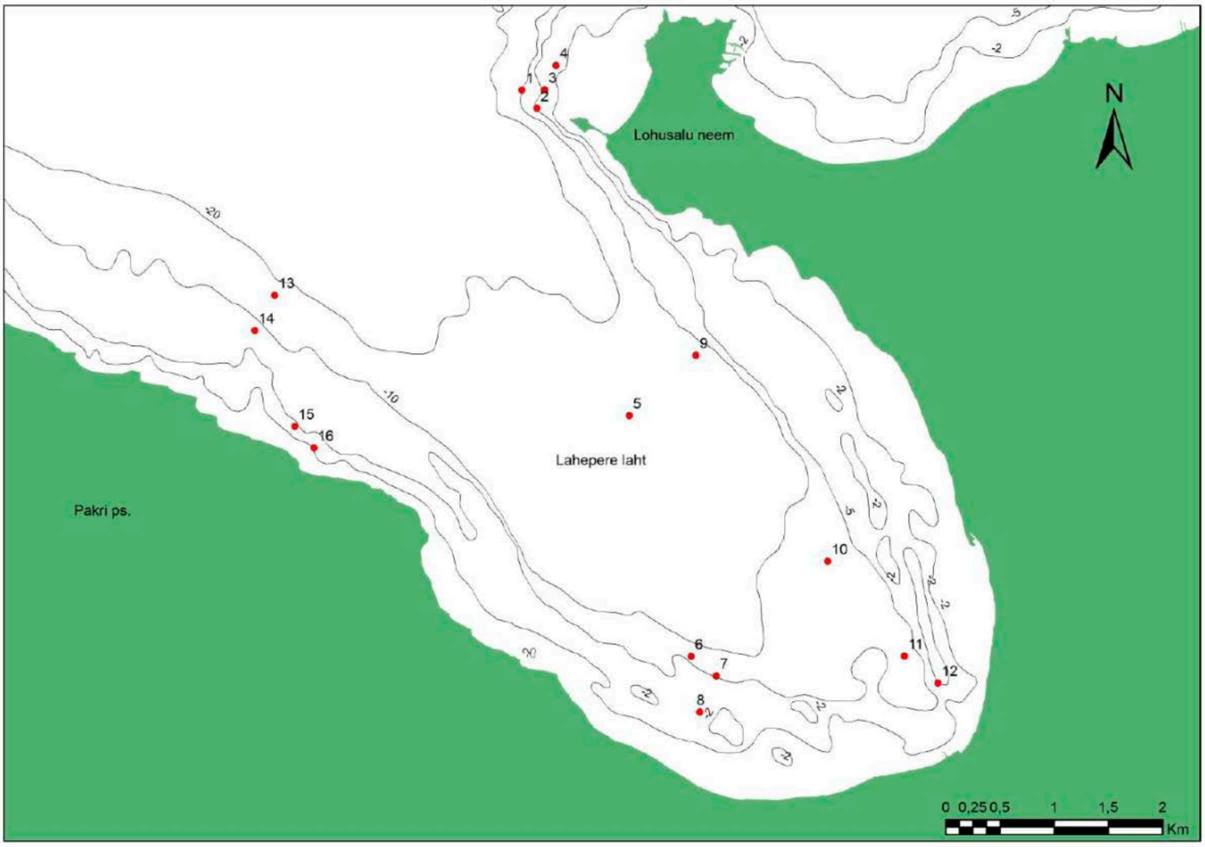


Figure 5-28. The positioning of "stations" for the study of fish in Lahepere Bay in August 2013.

It is highly probable that in addition to the fish species discovered through the survey, there could also occasionally be other fish species in Lahepere Bay. Continuous year-round surveys employing a large number of different fishing gear would be required to discover such species. The reason for this is that most of the undiscovered fish species are probably of a low abundance in the region, or more likely to be accidental visitors. This overview also specifies some species that are not reflected in the survey data or fishery statistics but one can assume that these species nevertheless exist in the area.

In addition to survey catches the fishery statistics of inshore fishermen were also used. These were useful because the fishermen operate on a year-round basis. Data have been stored on the basis of a small rectangle grid system (Figure 5–29). Data spanning six years have been used regarding the Lahepere Bay area from the period 2006–2013. Rectangles 148 and 152 for which data was collected cover Lahepere Bay. Both rectangles are bigger than Lahepere Bay, also covering coastal areas east and west from the bay, thus the harvest data that they describe concern a slightly wider area than the survey area. Fishermen's catches provide valuable information above all regarding the commercial fish species and fisheries. At the same time, fishermen's statistics are not helpful in the case of small-bodied and (or) protected fish species because small-bodied fish species are not caught by the traps of fishermen and the protected species must be released alive, therefore they are not reflected in the fishery statistics.

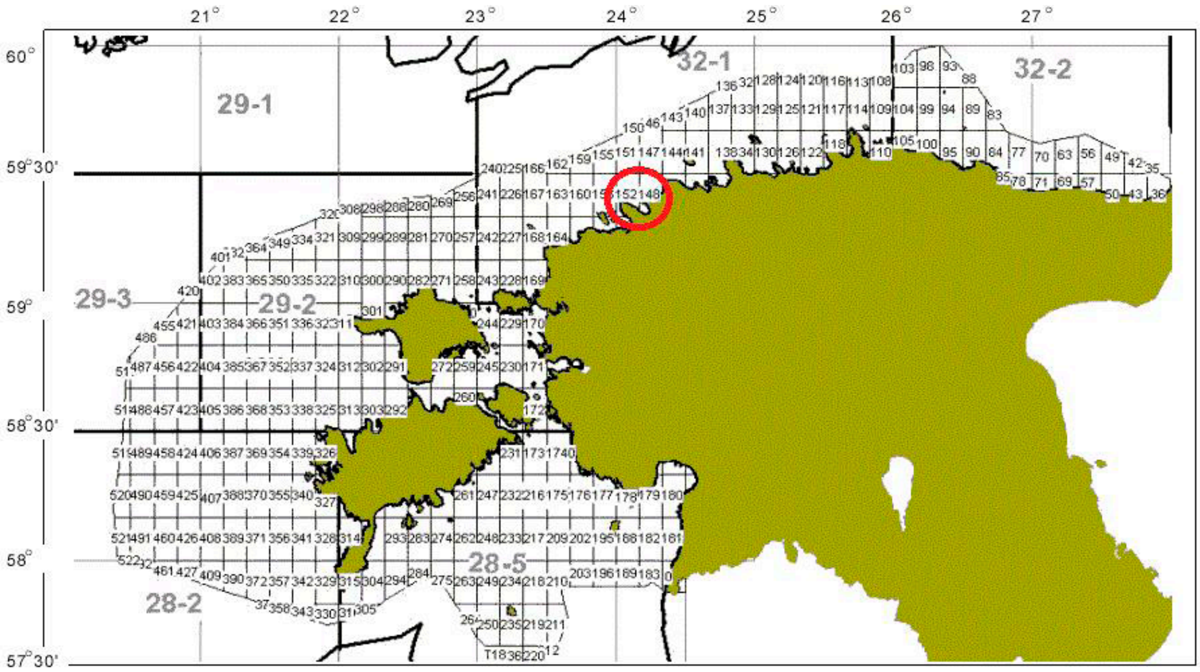


Figure 5–29. Small statistical rectangles of fishery in the Exclusive Economic Zone of Estonia and in the western Gulf of Finland.

Description of fish

The following provides a list and descriptions concerning the abundance of fish species found in Lahepere Bay. Less-important species are listed and full descriptions can be found in survey report *(UT EMI 2013)*

River lamprey *(Lampetra fluviatilis)*, twait shad (*Alosa fallax*), rainbow trout (*Onchorhynchus mykiss*); European smelt (*Osmerus eperlanus*, minnow (*Phoxinus phoxinus*), tench (*Tinca tinca*), common rudd (*Scardinius erythrophthalmus*), bleak (*Alburnus alburnus*), bream (*Abramis brama*), Crucian carp (*Carassius carassius*) and Prussian carp (*Carassius gibelio*), common carp (*Cyprinus carpio*), Eastern Baltic cod (*Gadus morhua callarias*), burbot (*Lota lota*), three-spined stickleback (*Gasterosteus aculeatus*), ninespine stickleback (*Pungitius pungitius*), pike-perch (*Sander lucioperca*), Eurasian ruffe (*Gymnocephalus cernuus*), viviparous blenny (*Zoarces viviparus,* round goby (*Neogobius melanostomus*), turbot (*Scophthalmus maximus*) and Baltic herring (*Clupea harengus membras*) – an abundant fish species in the Baltic Sea with a pelagic lifestyle and one of the most significant fish that are caught in Estonia. Lahepere Bay is an important feeding and spawning ground for the Baltic herring and a nursery ground for juvenile specimens. Abundance in Lahepere Bay varies depending on the location and time of year. According to survey data and official fishery statistics the Baltic herring is most abundant during the spawning period from April to July when the abundance of spawning Baltic herring probably exceeds the other fish species in the bay (Figure 5–30). Based on survey data and official fishery statistics, it can be concluded that during the spawning period Baltic herrings gather in the inner part of the bay, in shallower areas, while during the rest of the time they are also moving around in the outer part.

A separate chapter addresses the spawns of the Baltic herring in Lahepere Bay.

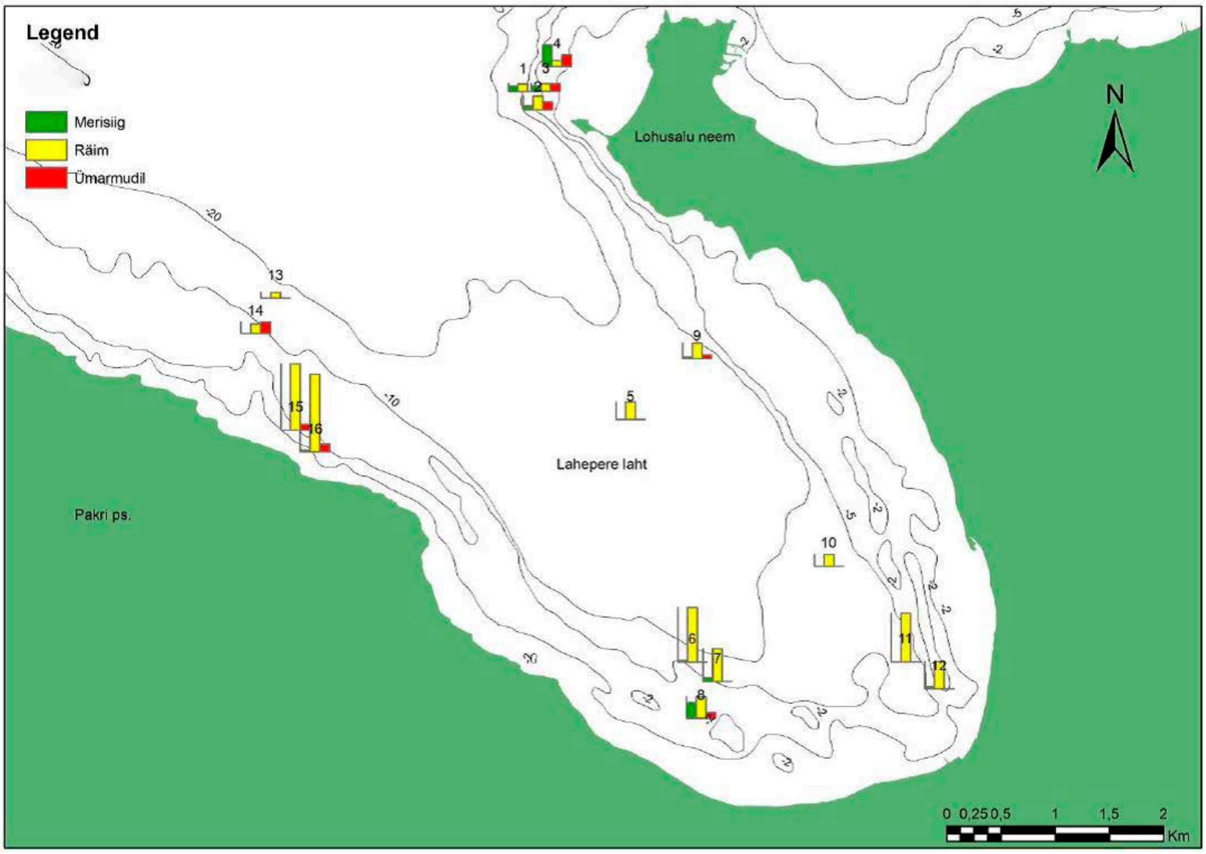


Figure 5–30. Abundance of the lavaret (*Coregonus lavaretus*), Baltic herring and round goby in the gillnets in Lahepere Bay in August 2013.

Sprat *(Sprattus sprattus balticus)* – A very important species in the Baltic Sea ecologically and commercially, and also very widespread in Estonian offshore waters. According to survey data and fishery statistics for Lahepere Bay, there are very few sprats in the bay. The official commercial catch caught from small rectangle 148 over the period from 2006 to July 2013 was only 3 kg. The low abundance of the sprat in Lahepere Bay is caused by the fact that it is a pelagic fish that only moves and spawns offshore and almost never comes to coastal waters.

Brown trout *(Salmo trutta trutta)* – A commercially important migratory fish species in the Baltic Sea. The catch from rectangle 148 exceeds that of rectangle 152. Among rivers connected to Lahepere Bay, the brown trout spawns in Treppoja in larger numbers and in the adjacent Pakri Bay. This species spawns in the rivers of Kloostri and Vasalemma. According to official fishery statistics, the brown trout is abundant in Lahepere Bay and is also substantial in catches.

Pike *(Esox lucius)* – mainly a freshwater species, commercially important, also inhabits low-salinity coastal areas in Estonia. The pike is not sensitive to water quality; all it requires is the existence of vegetation. According to official fishery statistics, pike were significantly more prevalent in the catch in small rectangle 152, a fact that is probably caused by the aforementioned rectangle partially also encompassing Pakri Bay, which contains biotopes suitable to freshwater species to a greater extent than Lahepere Bay. Nevertheless, according to surveys and official fishery statistics, it can be concluded that the pike does probably not have substantial spawning grounds in Lahepere Bay and in its close proximity. On the other hand, the fact that more pike are caught in Lahepere Bay outside the spawning period in the second half of summer and autumn indicates that this region is important for the pike as a feeding ground, where fish spawning further away travel to for feeding.

European eel (*Anguilla anguilla*) – A very important migratory fish species commercially that spends the majority of its life in freshwater. At times, it is abundant in Lahepere Bay. Eels have been caught substantially more from small rectangle 148. The species has been designated as "data deficient" in terms of category in the Red List of Estonia.

Roach (*Rutilus rutilus*) – A freshwater fish that in the Baltic Sea has adapted to life in bays with conditions of brackish water and low-salinity water. Commercially, the species is not of high importance but a lot of it is caught in Lahepere Bay and its close proximity, particularly much is caught in small rectangle 152. In Lahepere Bay, the species primarily inhabits shallower areas of the sea of up to 3 m. Lahepere Bay and its close proximity are not of particularly great importance as a spawning ground for the roach, however, this region is of importance for the roach as a feeding ground, where fish spawning further away travel to for feeding.

Ide *(Leuciscus idus*) – Common everywhere in the Estonian coastal sea, although in many areas there are only a few specimens. The catch by fishermen is average compared to other species. Lahepere Bay and its close proximity are not of particularly great importance as a spawning ground for the ide, however, this region is of importance for the ide as a feeding ground, where fish spawning further away travel to for feeding. The species has been designated as "data deficient" in terms of category in the Red List of Estonia.

Gudgeon (*Gobio gobio*) – A common fish all across Estonia. The species prefers bodies of water with a sandy bottom that are rich in oxygen. There is no particular commercial importance. During the survey catches in 2013 (seine fishing), one specimen was caught, therefore the species is probably of a low abundance in Lahepere Bay. The species has been designated as "data deficient" in terms of category in the Red List of Estonia.

Vimba bream (*Vimba vimba*) – Two types of vimba bream inhabit Estonia – the brackish water vimba bream and freshwater vimba bream. The vimba breams present in Lahepere Bay are those of the brackish water variety, living and feeding in the coastal sea and traveling to spawn in rivers. The existence of the vimba bream in Lahepere Bay is only reflected in the official fishery database of fishermen where vimba breams have been caught in both statistical rectangles in relatively low quantities. The species has been designated as "data deficient" in terms of category in the Red List of Estonia.

Spined loach (*Cobitis taenia*) – A fish living in freshwater and brackish water that prefers water bodies with a muddy-sandy bottom. They are not reflected in fishery statistics or survey catches, but may nonetheless be present in Lahepere Bay in low numbers. The species has been designated as "data deficient" in terms of category in the Red List of Estonia.

Garfish (*Belone belone)* – A schooling species of fish with a pelagic lifestyle that spends the majority of its time in the Atlantic Ocean, and mainly only stays in the Baltic Sea during its spawning period. According to commercial fishery data, garfish are mainly gathered in the statistical rectangle 148 during their spawning period, indicating the importance of the Lahepere Bay area as a spawning ground for this species. Spawning is also confirmed by the garfish fry caught by seine fishing. According to literature, garfish fry should have left our coastal waters by August, therefore it may be assumed that of the garfish born in Lahepere Bay most had already left by the time that seine fishing took place (in August).

Straightnose pipefish *(Nerophis ophidion)* **–** A fish of up to 30 cm in length inhabiting the European coastal sea (including Baltic Sea) that lives between plants in the foreshore. In Estonia, the occurrence of straightnose pipefish is higher in Väinameri and the Gulf of Riga. Few specimens have been caught in Lahepere Bay only via survey catches in 2009, but due to its small body, the species does not get caught in nets particularly easily., It can therefore be assumed that it is actually more abundant in Lahepere Bay. The species has been designated as "data deficient" in terms of category in the Red List of Estonia.

Perch (*Perca fluviatilis*) – A fish species with very wide distribution in Estonia. It inhabits lakes, rivers, ponds and brackish waters. The perch is a valued and significant commercial fish, and also an important species in Lahepere Bay, where in fishery it is the second most abundant species after the flounder (*Platichthys flesus*) and the Baltic herring. According to survey data, the perch inhabited approximately equally various depths (Figure 5-31). The perch mainly uses Lahepere Bay for feeding purposes, but it is probably the only freshwater species that also spawns there in the period from May to June, when the water temperature has risen to the range of 8...14°C.

Lesser sand eel (*Ammodytes tobianus*) – A very common species of fish in some areas of the Estonian coastline, but only one specimen has been caught by seine fishing from Lahepere Bay. The species prefers a sea of up to 10 m in depth with a sandy bottom. There is little information concerning the abundance in Lahepere Bay. However based on preferences with regard to habitat, it could be assumed that the area is nonetheless suitable for the lesser sand eel. The species has been designated as Data Deficient (DD) in terms of category in the Red List of Estonia.

Great sand eel (*Hyperoplus lanceolatus*) – One great sand eel was caught in a survey in the summer of 2009. As the great sand eel is a relatively rare species of fish on our coast, the fact that it was caught in 2009 was probably accidental, and it does not constitute a

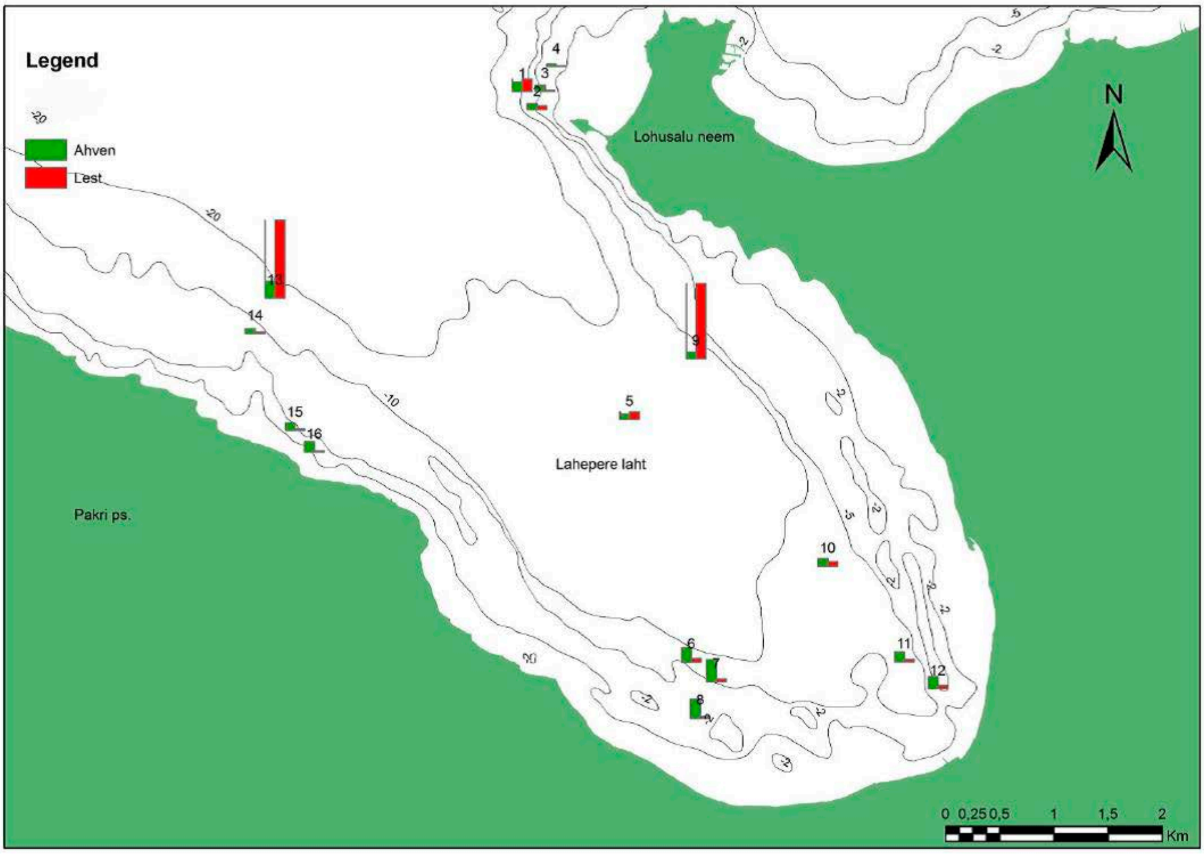


Figure 5-31. Abundance of the perch and the flounder in gillnets (stations) in Lahepere Bay in August 2013.

significant species in Lahepere Bay. The species has been designated as Data Deficient (DD) in terms of category in the Red List of Estonia.

Black goby (*Gobius niger*) – A marine fish living at a depth of up to 20 m in the littoral zone of a coastal area or on sandy bottoms. It was absent from the catches of fishermen, and only a few specimens were found in the catches using gillnets. Thus, there is little information concerning the abundance of this species in Lahepere Bay. The species has been designated as Data Deficient (DD) in terms of category in the Red List of Estonia.

Sand goby (*Pomatoschistus minutus*) – The primary range of the species is the coast of the Atlantic Ocean from Portugal to the North Sea and Baltic Sea. The fish live in waters of approximately 20 m in depth and very rarely up to 70 m in depth. It is a very common species of fish in some areas of Estonia. In summer, they live in shallower waters and move to deeper waters for the winter. The species is included in Annex III of the Berne Convention – animals whose capture and hunting must be regulated. However, the sand goby is not endangered in Estonia. In seine fishing in 2013, only a few specimens were caught, thus there is little information concerning the abundance of this species in Lahepere Bay. It is of no commercial significance. However, it is an important food item for larger fish.

Common goby (*Pomatoschistus microps*) – In seine fishing in Lahepere Bay in 2013, numerous specimens were caught, which gives reason to conclude that the species is abundant in Lahepere Bay. It is of no commercial significance. However, it is an important food item for larger fish. The species is included in Annex III of the Berne Convention – animals whose capture and hunting must be regulated. The species has also been designated as Data Deficient (DD) in terms of category in the Red List of Estonia. The species is very abundant in some areas of Estonian waters and is not endangered.

Short-horn sculpin (*Myoxocephalus scorpius*) – A species inhabiting all the marine waters of Estonia, though depending on the area, preferring deeper regions in the Gulf of Riga and Gulf of Finland and on the western coast of the islands. The short-horn sculpin stays near the coast in water of up to 60 m in depth. It mainly lives on a rocky bottom that also contains a little bit of mud and sand. In Lahepere Bay, the short-horn sculpin has not been caught in survey catches or by fishermen, but presumably the species can nevertheless exist there. The species has been designated as Data Deficient (DD) in terms of category in the Red List of Estonia and is included in Annex III of the Berne Convention.

Lumpfish (*Cyclopterus lumpus*) – A species of fish that likes the cold, and only comes to bays such as Lahepere in cases of very low water temperature and in greater numbers only during the spawning period in spring. According to official catch statistics, only a few specimens of this species have been caught over a six year period. There is no information regarding its potential spawning. The species has been designated as Data Deficient (DD) in terms of category in the Red List of Estonia.

Longspined bullhead (*Taurulus bubalis*) – A species of fish that likes the cold with a benthic lifestyle which is generally low in abundance in Estonian marine areas. It was present in survey catches in the form of a few specimens, and was not reflected in fishery statistics. Longspined bullheads are more abundant in the western region of the Gulf of Finland, a region that includes Lahepere Bay. The species has been designated as Data Deficient (DD) in terms of category in the Red List of Estonia.

European flounder (*Platichthys flesus trachurus*) – A marine fish that is distributed across the entire Estonian coastal sea. The European flounder lives at a depth of up to 40 m on a sandy or clay bottom. In some rare cases, it may also come to the estuaries. It is a solitary species that moves around quite a lot. It can travel long distances when seeking spawning grounds. It is the most abundant species of fish in survey catches of Lahepere Bay. In the survey catches in the second half of August 2013, when the water of the bay had warmed up all the way to the bottom, it was found that European flounders prefer the deeper areas of the bay. Overall during this period, the yield of the European flounder (as well as the overall yield) was highest at a depth of 15 m.

Two types of the European flounder species can be found in the Baltic Sea. One of these types also spawns at the tip of islands and peninsulas of the Gulf of Finland, the other spawns in deep areas, mainly in the Gotland region. The abundant European flounders from the summer-spawned cohort that were caught by seine fishing indicate that there could be spawns of the European flounder in the areas of Pakri and Lohusalu cape. The European flounders from the summer-spawned cohort that were caught by seine fishing indicate that Lahepere Bay is also of a local importance as a valuable nursery ground for juvenile European flounders and a feeding ground for older specimens.

Species included in the Annexes to the Habitats Directive

The species that are at the core of nature conservation interest from the standpoint of European Union legislation are included in Annex II to the Habitats Directive. EU Member States must form special areas of conservation for the protection of such species and the sites must be managed in accordance with the ecological requirements of the particular species. Member States must take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated. At the same time, there may be situations where a significant region of a Member State already has a conservation area with the appropriate protection regime in place. In such cases, the establishment of an additional separate conservation area is not necessary.

Annex IV to the Habitats Directive includes species in need of strict protection, where the designation of special areas of conservation is not necessary, but each Member State must protect them in their natural range. All forms of deliberate capture of species under strict protection are prohibited. Among fish species listed in Annex IV to the Habitats Directive, only the European sea sturgeon (*Acipenser sturio*) may theoretically be found in Estonia. However, it is extremely rare in the whole of the Baltic Sea.

Annex V includes species whose taking from the wild can be restricted by European law and therefore also need attention. European whitefish and atlantic salmon, both present in Lahepere bay, belong to this Annex.

Species listed in the Annexes to the Habitats Directive that were captured in the course of field work carried out in Lahepere Bay or the species that probably exist there are provided in Table 5–6.

Table 5–6 Fish species listed in Annexes to the Habitats Directive living in Lahepere Bay.

Species in English	Name in Latin	Listed in annexes
European whitefish	*Coregonus lavaretus*	V
Bullhead	*Cottus gobio*	II
Atlantic salmon	*Salmo salar*	II, V

European whitefish (*Coregonus lavaretus*) – A commercially important migratory fish in the Baltic Sea. The European whitefish of the Estonian coastal sea are divided between different forms, some of which spawn in the sea and the others in a river. The European whitefish spawning in the river are today quite abundant in Estonia, but their abundance is to a significant extent based on artificial reproduction, and the majority of the naturally breeding specimens of these forms of European whitefish spawn in the rivers of Finland. Forms of the European whitefish that spawn in the sea are more rare and threatened – only a few spawning grounds remain in Estonian coastal waters. Lahepere Bay is a feeding area for European whitefish spawning in rivers and for European whitefish spawning in the sea. Among the European whitefish captured in the course of field work, 18% were the local threatened form of European whitefish, whose closest spawning areas could be located around the Pakri Islands in Pakri Bay, where spawning specimens have been caught during national surveys. No data is available regarding the spawning grounds of the European whitefish in Lahepere Bay, and natural conditions in the bay do not lead us to believe that the European whitefish could more widely spawn in the bay.

In the survey of 2013, more European whitefish were caught from stations located in shallow water (3 m), but presumably the preferences of this species with regard to water depth vary depending on the season. The species has been designated as Data Deficient (DD) in terms of category in the Red List of Estonia.

Bullhead (*Cottus gobio*) – Primarily a freshwater species that can also inhabit brackish waters in coastal areas. The species is quite common in the Gulf of Finland. The species is probably quite abundant in Lahepere Bay, although it is seldom caught in gillnets and seines because the fish are small in size and tend to hide under rocks. The bullhead is included in Category III of protection of Estonia's nature conservation. It is believed that the bullheads living in Estonian freshwater and sea belong to two separate groups within the species, but this subject requires further research. If such information proves to be true, the bullhead should be granted protection in the coastal sea. At the same time, the protection of this species (in terms of the conservation of the gene pool of the species) in the sea is already assured with a very high probability by the existing conservation areas (for example, the national parks of Vilsandi and Lahemaa).

Atlantic salmon (*Salmo salar*) – A very important species of fish commercially in the Baltic Sea, also caught in relatively high numbers in Lahepere Bay. The adult (i.e. transitioned to a marine lifestyle) specimens of the Atlantic salmon probably come to Lahepere Bay quite often when they migrate for spawning. This marine area is nonetheless not of crucial importance to this species. The closest known spawning ground of the Atlantic salmon is Vasalemma River, which flows into Pakri Bay. According to fishery statistics, the Atlantic salmon is caught more in statistical rectangle 148. The species has been designated as Critically Endangered (CE) in terms of category in the Red List of Estonia.

Other species of importance from the standpoint of nature conservation

In addition to the species provided in the annexes to the Habitats Directive, multiple species of fish requiring attention from the standpoint of nature conservation are found in Lahepere Bay as already described above. The most attention should be given to the Atlantic salmon, designated as Critically Endangered (CE) in terms of category in the Red List of Estonia, and the European smelt, designated as Near Threatened (NT) in terms of category. Furthermore, the following species included in the category Data Deficient (DD) need attention: lesser sand eel, eel, spined loach, European whitefish, lumpfish, gudgeon, black goby, great sand eel, ide, straightnose pipefish, common goby, short-horn sculpin, longspined bullhead, as well as the following species included in Annex III to the Berne Convention: sand goby, common goby and shorthorn sculpin. The category Data Deficient (DD) does not indicate a direct threat, but as it is not possible to determine the degree of endangerment of a species designated as such due to insufficient data on abundance and distribution, these species should be viewed with caution and an attempt should be made to collect more extensive information.

Spawning ground studies

Commercial fishery catch data indicate that during the spawning period, species such as the Baltic herring, European flounder and garfish have gathered in Lahepere Bay, which implies that these species also spawn there. Of freshwater fish species, the perch probably spawns there in greater numbers.

The spawning period of the Baltic herring lasts from April to July. The spawning grounds of Baltic herrings have several prerequisites and characteristic features.

- Depth of 2–10 m, optimal depth of 3–6 (8) m.
- Rocky and sandy-gravelly seabed that provides favorable conditions for vegetation. A seabed that is not muddy is suitable.
- Existence of vegetation – the more vegetation there is, the better the substrate for spawning.
- Preferred species of phytobenthos are red algae *F. lumbricalis*, *C.tenuicorne*, *P. fucoides*; brown algae *P. littoralis,* and flowering plant common eelgrass.
- Absent are such plants as bladderwrack, green alga *C. glomerata*, and other green algae that resemble it without a strong structure.
- Water must flow, therefore the spawning grounds are frequently located close to capes, around small islands, open sea shoals or in small bays that are very open to the sea (including Lahepere Bay, for example).
- Salinity is of little importance.
- The near-bottom temperature is important. Spawning begins at a temperature of 4–5 °C, mass spawning begins at a temperature of 9 °C and lasts until 15 °C.
- The slope gradient may or may not be important. At a higher gradient, the flow of water is better, but the zone suitable for spawning is usually narrower.
- Water transparency is not very important, but places with higher transparency also have better vegetation conditions that in turn are favorable for spawning.

Garfish use similar spawning grounds to Baltic herrings, also preferring sea areas rich in vegetation because their eggs are attached to vegetation. Such areas ensure sufficient oxygen supply. Garfish eggs die if they fall onto the seabed. Spawning starts when water temperature has risen to 10–14 °C, which typically happens at the end of May/beginning of June. Garfish generally stay in Lahepere Bay and Estonian coastal waters in general only for a short period of time – up to a few weeks after spawning for feeding purposes. Thereafter, they return to the Atlantic Ocean. Young fish depart later when autumn arrives after they have achieved the body size of an adult fish.

The European flounder spawns in May to June. Its eggs develop under rocks, therefore a seabed containing rocks is suitable for the European flounder. Depending on the water temperature, the development of the eggs takes 5 to 10 days.

The perch spawns when the water temperature reaches 8°C, which typically happens in May or June. It is quite tolerant with regard to spawning conditions. Its egg band attaches to the tree trunks and rocks in the water body.

The spawning grounds of the Baltic herring were studied more extensively.

Spawning substrate of Baltic herring

The Baltic herring prefers to spawn in areas where the following species of phytobenthos are distributed: red algae *F. lumbricalis, C. tenuicorne, P. fucoides*; brown alga *P. littoralis* and the flowering plant common eelgrass.

Vegetation suitable as spawning substrate for the Baltic herring was mainly distributed at depths of 4.2 to 10.1 m. The cover (%) of the specified plant species with regard to the bottom substrate in the region of the pipeline route and nearby is provided below according to data from 2009.

- Black carrageen – ca. 10%. On the east coast of Pakri Peninsula, absent in the inner part of the bay.
- Red alga *C. tenuicorne* – ca. 30% or below. On the east coast of Pakri Peninsula, absent in the inner part of the bay.
- Red alga *P. fucoides* – max. 50%. On the east coast of Pakri Peninsula, little in the inner part of the bay.
- Brown alga *P.* – ca 50% or below. Distributed on the east coast of Pakri Peninsula and in shallower waters of the inner part of the bay.
- Common eelgrass – plentiful in the southern part of the bay, cover of up to 70%. Absent on the east coast of Pakri Peninsula.
- In summary, in some parts areas covered by common eelgrass were very widespread and also had the highest overall vegetation cover – up to 50%. Concerning filamentous algae, the most widespread was *P. littoralis*, to a lesser extent *C. tenuicorne* and *P. fucoides* filamentous algae were present. All of the listed algae are plants on which the Baltic herring prefers to spawn. There was little black carrageen found.

Distribution of Baltic herring larvae and eggs in the survey area

Baltic herring usually start spawning in the Gulf of Finland at the end of May (beginning of June). Because of a late spring in 2013, Baltic herring did not start spawning until later in the second decade of June. In the Rassi trawl samples collected on 12 June, Baltic herring eggs were found inside filamentous algae on the proposed route of the gas pipeline. The quantity of eggs was not yet on a massive scale. The surface layer of water also still contained only a very small amount of Baltic herring larvae.

The presence of Baltic herring eggs and larvae on the route of the proposed pipeline indicates that the spawning of the Baltic herring occurs in this region.

In conclusion, the European flounder can be considered to be the most abundant fish species in Lahepere Bay according to survey catches and official fishery statistics. The European flounder prevailed in the fishermen's catches in terms of weight in both statistical rectangles 148 and 152. The next most abundant species are the perch and the Baltic herring. Fishermen's catches also contain a lot of brown trout, European whitefish and Prussian carp in terms of weight.

Lahepere Bay is not unique with regard to its fish fauna, but the species diversity is relatively high. As the bay is open to northerly winds and is of a relatively high salinity, it does not contain spawning grounds that are important for freshwater fish species. Of the most important freshwater fish species, only the perch probably spawns in the bay in greater numbers. Most of the freshwater species that feed in the bay probably prefer to spawn in the nearby Pakri Bay and between the Pakri Islands, where fishing is prohibited precisely due to fish spawning grounds. Lahepere Bay, however, is an important spawning ground for marine fish. As the surveys indicated, the bay is above all of importance as a spawning ground for the Baltic herring. Species that also probably spawn in the bay are the European flounder and garfish, which are both very important fish species from a commercial standpoint.

5.1.11 Bird fauna

Gulf of Finland

With a multitude of islands and islets as well as plenty of eutrophic bays and inlets and sandy beaches, the Gulf of Finland is an important nesting area for many bird species in the Baltic Sea area. The area is of significance to nesting aquatic and shore birds in particular but also to some species of birds of prey and passerines. As a bird-nesting environment the Gulf of Finland is characterized by its barrenness. The coastal bays and inlets and shallow inner archipelago offer nutrient-rich habitats, but the islands and islets of the outer archipelago are barren. Therefore the Gulf of Finland is also an appropriate nesting area for many nesting species of the northern tundra, such as Barnacle Goose (*Branta leucopsis*), Eider (*Somateria mollissima*), Scaup (*Aythya marila*), Ringed Plover (*Charadrius hiaticula*) and Arctic Tern (*Sterna paradisaea*). On the other hand, some species of oligotrophic inland waters, such as Goosander (*Mergus merganser)* and Red-breasted Merganser *(Mergus serrator)*, Common, Herring and Lesser Black-backed Gull (*Larus canus, L. argentatus* and *L. fuscus*), Common Tern (*Sterna hirundo*) and Common Sandpiper (*Actitis hypoleucos*) are also common in the outer archipelago. Some passerine birds of mires and open habitats, such as Meadow Pipit (*Anthus pratensis),* White Wagtail (*Motacilla alba*) and Wheatear (*Oenanthe oenanthe*) commonly nest in the archipelago of the Gulf of Finland. Consequently, the nesting bird population of the Baltic Sea and, subsequently, that of the Gulf of Finland is a mixture of species representing many different zoogeographical areas and habitats (see also *Hildén & Hario 1993*).

The birds nesting the Gulf of Finland archipelago include five species listed in Annex I to the EU Birds Directive. Velvet Scoter (*Melanitta fusca*) is the only species of bird nesting in the Gulf of Finland classified as threatened by the International Union for Conservation of Nature (IUCN), with is classification being Endangered (EN). Also occurring in the Gulf of Finland during migration periods and in the winter are Long-tailed Duck (*Clangula hyemalis*) and Steller's Eider (*Polysticta stelleri*), both of which are internationally classified as Vulnerable (VU). Special mention is deserved by the nominate subspecies of Lesser Black-backed Gull (*Larus fuscus fuscus)* almost endemic to the Baltic Sea area which, in addition to the Baltic Sea, also nests in inland areas of Finland and Russia all the way to the White Sea.

The Gulf of Finland is also an important area for migratory birds. Millions of aquatic and shore birds nesting in the Arctic tundra (Anseriformes, Gaviiformes, cormorants, waders and skuas) follow the coastline of the Gulf of Finland when migrating from their overwintering areas in Western Europe or the southern rim of the Baltic Sea to Russia and further to the northern tundra. For some species a significant proportion of the entire world population migrates through the area. Clearly the most numerous species are Barnacle Goose, Brent Goose (*Branta bernicla*), Long-tailed Duck and Common Scoter (*Melanitta nigra*) whose total daily numbers can exceptionally exceed 100,000 individuals (*Toivanen 2014*). Other numerous migratory birds include Wigeon (*Anas penelope*), Velvet Scoter, Scaup, Red-throated Diver (*Gavia stellata*) and Black-throated Diver (*G. arctica*) and in some years Greater White-fronted Goose (*Anser albifrons*) and Tundra Bean Goose (*Anser fabalis rossicus*) (*Toivanen 2014*).

The specific routes taken by migrating arctic birds over the Gulf of Finland vary from year to year depending on the weather conditions. Winds in particular play a role in the routes taken in relation to the shoreline. The time of the year also plays a role: in the spring the flyway of aquatic birds primarily passes along the northern edge of the Gulf of Finland, while in the autumn they often take a path across the offshore areas or along the Estonian coast (*Toivanen 2014*). In the autumn and early winter a large number of aquatic birds, some of which are threatened or otherwise noteworthy species, rest and feed in the Gulf of Finland. In mild winters small numbers of aquatic birds may even attempt to overwinter in the area if the sea does not freeze over.

Lahepere Bay

Lahepere Bay is a breeding ground and resting area for many important species of birds, including several species included in the Annexes to the Birds Directive and protected species. Across the entire research area covering Lahepere Bay, the shore area and land area that may be impacted by the future pipeline, 86 species of birds were counted in addition to undetermined species from three groups of birds: Divers, Terns and Skuas.

Data from three studies have been used as a basis for making a summary on the birds of Lahepere Bay, conducted by the Estonian Ornithological Society specifically for the purposes of the Balticconnector project:

(a) mapping of breeding birds
(b) ship-based survey of water birds on stopover
(c) survey of water birds from coast

(a) Mapping of breeding birds. The survey area of nesting birds encompasses a region where the planned construction of gas pipeline may cause a change in habitat (partial destruction) or a significant disturbance to breeding birds during deforestation and construction work. The survey area has been divided into two, the boundaries of which are highly distinct in nature. Survey area 1 is located on the northern side of the Tallinn-Paldiski highway. Survey area 2 encompasses the area between the seashore and the first highway extending 800 m on both sides of the planned landfall point of the gas pipeline (Figure 5-32). During the survey, the breeding territories of birds in the survey area were mapped. Four survey trips took place on the following dates: May 15, May 28, June 11 and June 20, 2013. Generally speaking, the species in the area should be relatively well covered because the survey area was small.

(b) Ship-based surveys of water birds on stopover. In order to count birds on the open sea, route surveys from a ship were used based on the internationally used ship survey methodology (*Durinck 2005*) (Figure 5-33). Counting took place over the span of the various seasons in one year. Five surveys were carried out: two in the spring and one survey each in the summer, autumn and winter. Surveys were carried out on the

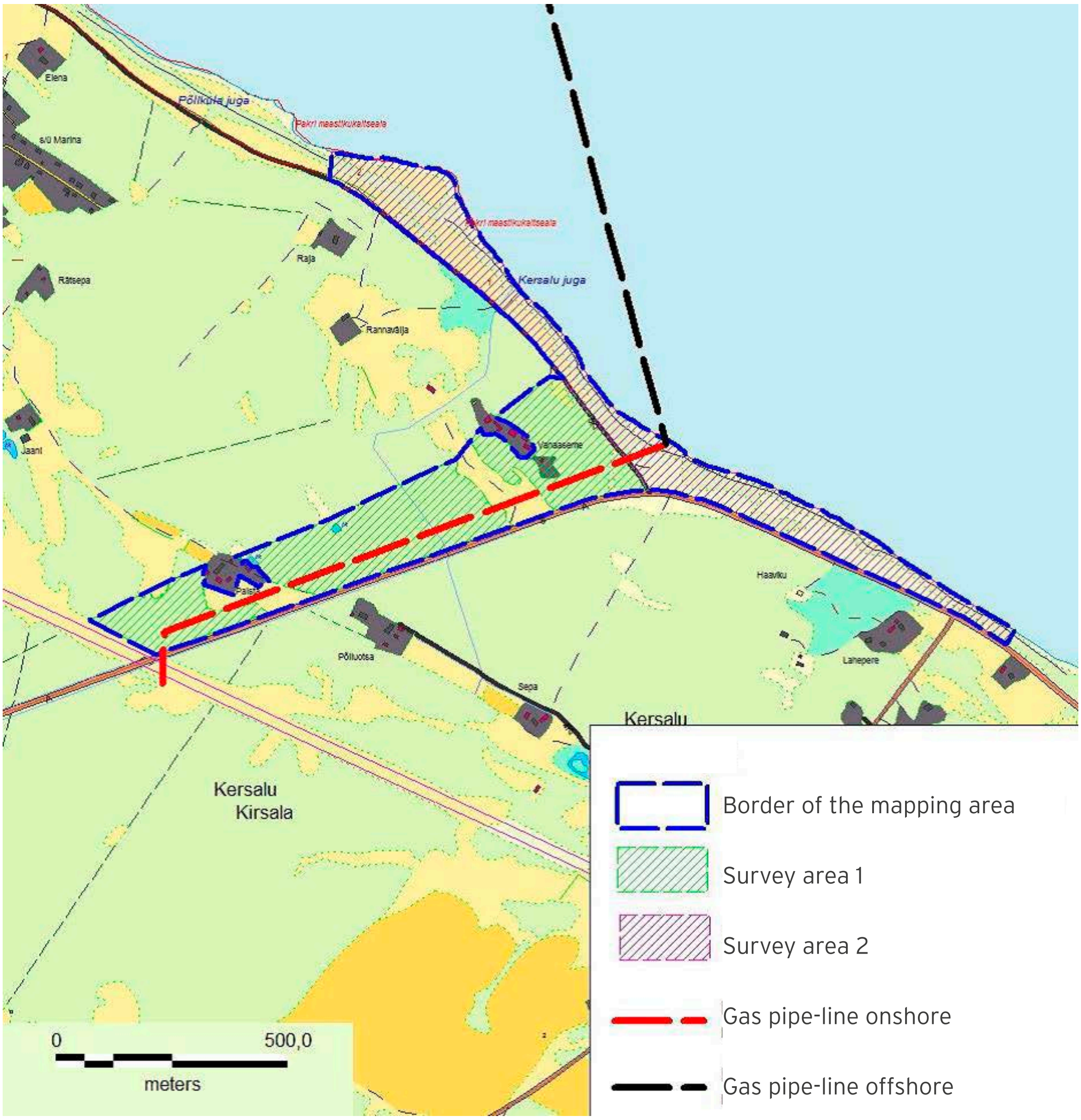


Figure 5-32 The mapping area of breeding birds and its division into two survey areas (Survey area 1 and Survey area 2 (Estonian Ornithological Society 2013).

following dates: August 5, November 20, 2013 and January 13, April 15 and May 7, 2014.

For practical purposes, birds of the open sea were classified into three function-based groups: species with a diet of submerged aquatic vegetation (most Anseriformes), piscivorous species (Diving Ducks, Divers, Grebes, Cormorants and Auks) and pelagic species (Skuas, Gulls and Terns). Unfortunately, it was not possible to determine the abundance estimate of Divers because all encountered species were outside the main band of the survey.

(c) Coastal survey methodology. Water birds on stopover in marine areas close to the coast and on the coast were counted from stationary monitoring stations (a total of 6 stations) using a field telescope (magnification of 20–60x). In the course of surveys, the species of birds seen and the number of specimens was recorded by monitoring stations (6 monitoring stations in total) (Figure 5-34). Surveys took place once or twice a month from May 15, 2013 to April 22, 2014. Altogether 21 surveys were carried out during the period.

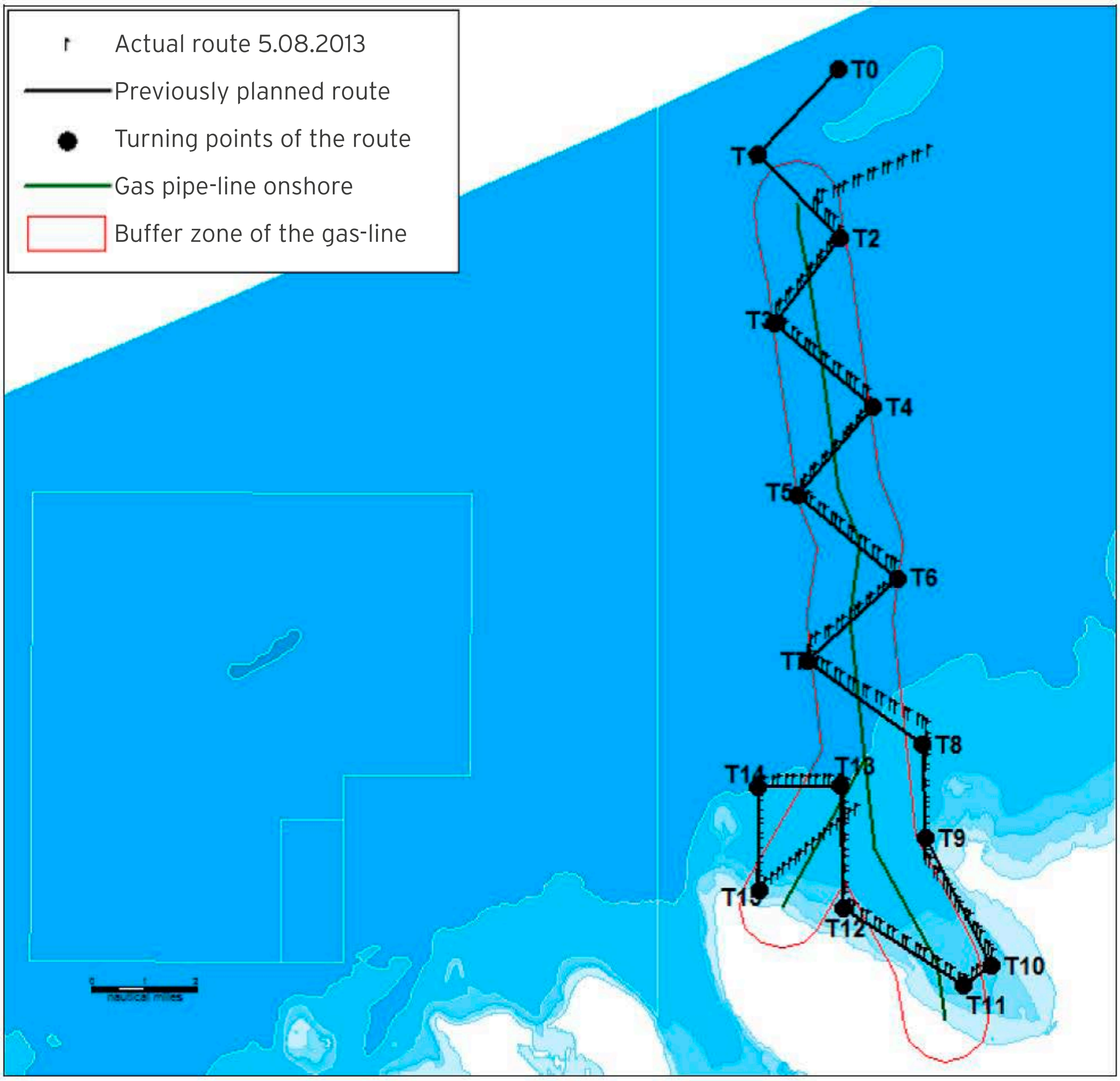


Figure 5-33. Route for counting birds from a ship (Estonian Ornithological Society 2013).

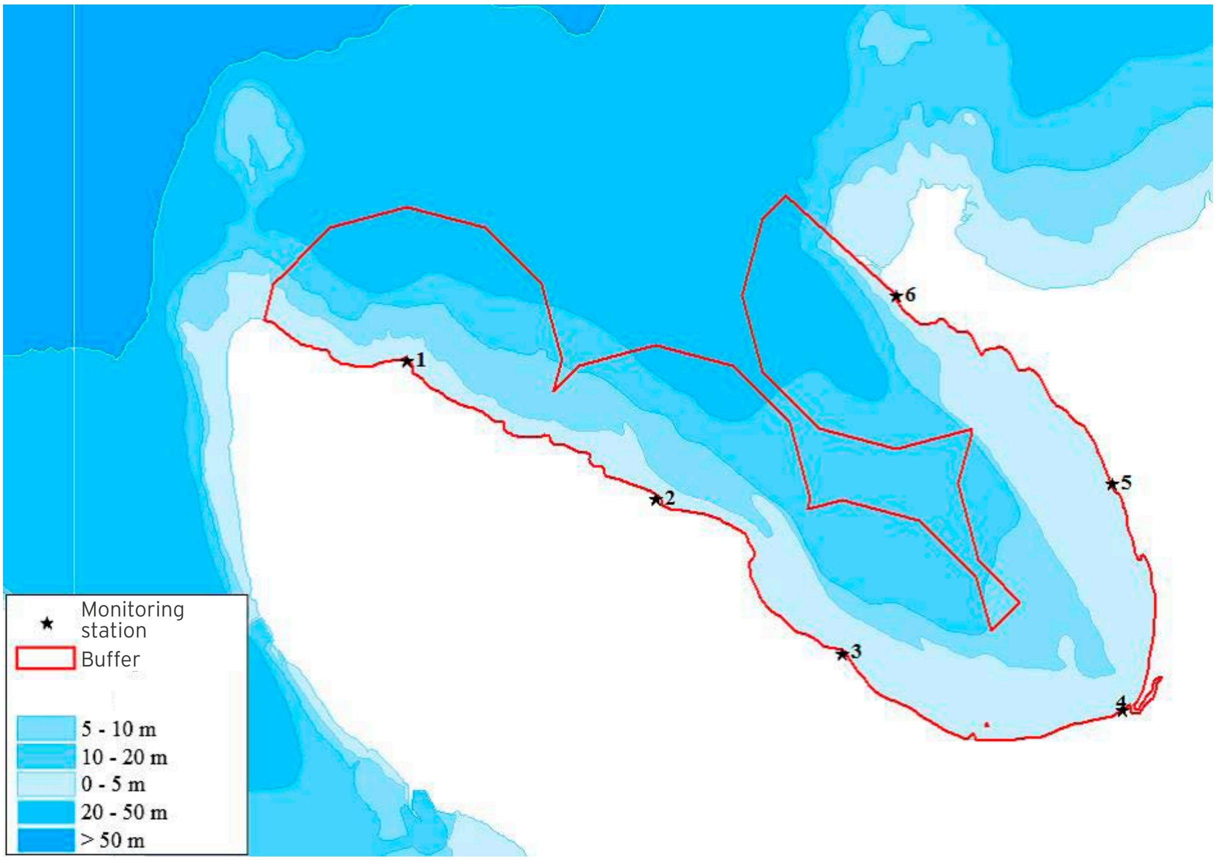


Figure 5-34. Coastal survey monitoring stations on the coast of Lahepere Bay (*Estonian Ornithological Society 2014*).

5.1.11.1 Breeding bird fauna

There were no marine species nesting in Survey area 1. Survey area 2, however, had 6 to 9 species of nesting shorebirds (Table 5-7). Several Anseriformes were seen in the survey area, but they may have nested elsewhere. At the same time, the coastal cliffs are a suitable natural nesting area for the Common Shelduck (*Tadorna tadorna*) and Goosander (*Mergus merganser*) as species preferring to build sheltered nests. Up to two pairs of Common Shelducks were recorded in the surveys, two pairs of Gadwalls (*Anas strepera*) were recorded (it nests on the ground) and two broods of Goosander were seen. The following Charadriiformes were represented: Common Sandpiper (*Actitis hypoleucos*) (up to 5 pairs, one nest with eggs was discovered), Common Pied Oystercatcher (*Haematopus ostralegus*) (1 pair), Little Ringed Plover (*Charadrius dubius*) (1 pair), Common Gull (*Larus canus*) (at least 6 pairs, nests were situated on stones in the sea without exception) and Arctic Tern (*Sterna paradisaea*) (1 pair). The White Wagtail (*Motacilla alba*) is also a common bird in coasts (6 pairs were recorded).

Table 5-7. Breeding bird fauna of Survey area 2.

Species		Abundance, pairs
Common Gull	*Larus canus*	6
White Wagtail	*Motacilla alba*	6
Common Sandpiper	*Actitis hypoleucos*	5
Goosander	*Mergus merganser*	2
Common Shelduck	*Tadorna tadorna*	2
Gadwall	*Anas strepera*	2
Common Pied Oystercatcher	*Haematopus ostralegus*	1
Arctic Tern	*Sterna paradisaea*	1
Little Ringed Plover	*Charadrius dubius*	1
Total		26

With regard to activities changing natural conditions, the cape that Little Ringed Plovers and Arctic Terns use as a habitat north-west of Kersalu Waterfall should be preserved.

Figure 5-35 shows the location of nesting birds in the survey area at various observation times, providing information regarding the time that birds most populate certain regions.

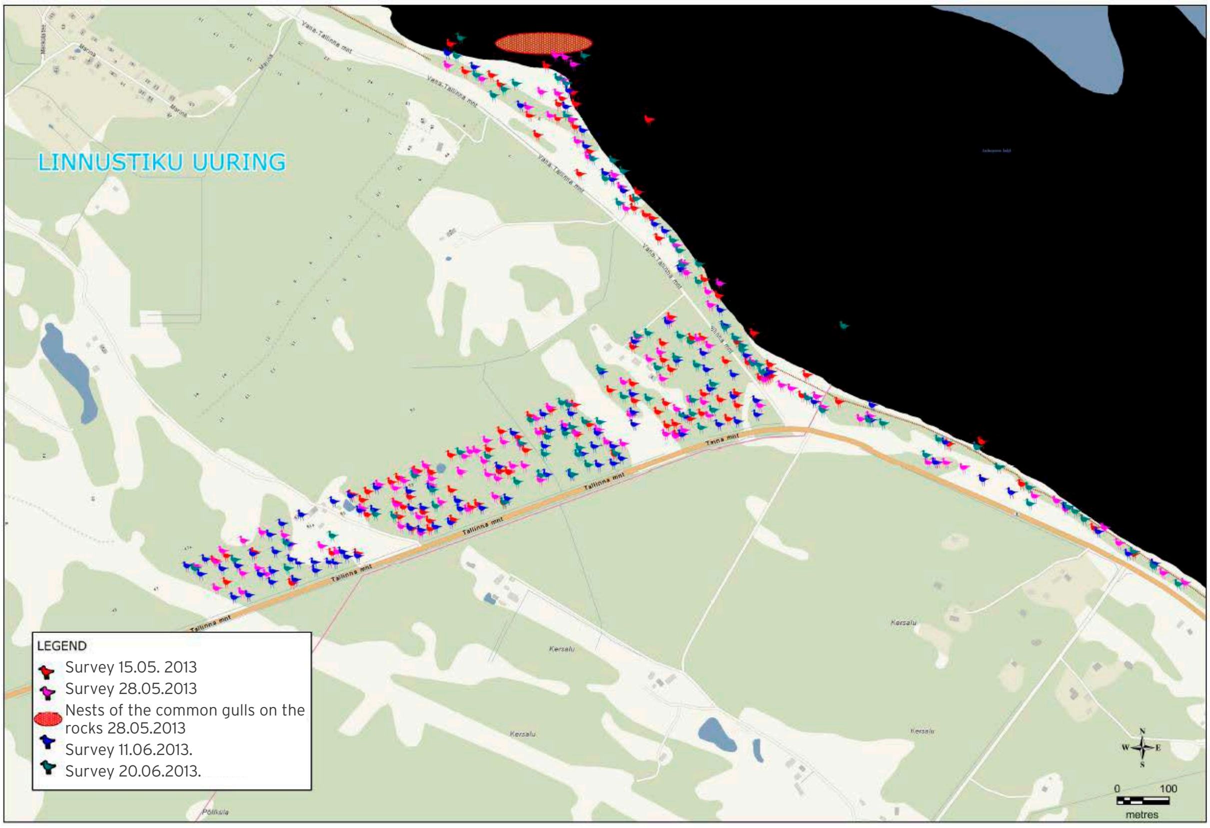


Figure 5-35. Location of nesting birds during various surveys. The legend shows the different dates of the surveys.

4.1.11.2 Water birds

Water birds were defined more broadly. The following species and groups of birds directly associated with the sea and coast were counted: Anseriformes, Divers (*Gaviiformes*), Grebes (*Podicipediformes*), Cormorant (*Phalacrocorax carbo*), Storks (Ciconiiformes), White-tailed Eagle (*Haliaeetus albicilla*) and Charadriiformes. No Gruiformes (*Gruiformes*) considered to be included in water birds were recorded as being on stopover in the surveyed area. Due to difficulties in determination, Divers, Terns and Skuas are traditionally discussed on a species group level.

Results of counting from a ship

In the course of ship survey, at least 22 species of water birds were encountered from eight families (Table 5-8). Among families, the Anatidae were the most numerous in species (at least 10 species), followed by gulls (5 species).

The most abundant species were the Long-tailed Duck (a total of approximately 23 200 birds on stopover were counted), Common Scoter (approximately 300 birds on stopover) and European Herring Gull (in excess of 500 birds counted in total). Anseriformes were the most abundant group of birds as they accounted for 97% of all specimens counted. The species with the highest incidence (they were encountered in all of the times surveyed) were the Velvet Scoter, European Herring Gull and Common Gull.

Table 5-8 Water birds encountered in ship surveys.

Species	Total birds counted	Including birds on stopover	Frequency %
Anseriformes *Anatidae*			
Unidentified Swan (*Cygnus sp.*)	11	0	
Unidentified Black Goose/Goose (*Anser/ Branta sp.*)	170	50	20
Northern Pintail (*Anas acuta*)	6	0	
Common Eider (*Somateria mollissima*)	192	146	40
Long-tailed Duck (*Clangula hyemalis*)	23 660	23 197	80
Common Scoter (*Melanitta nigra*)	554	308	60
Velvet Scoter (*Melanitta fusca*)	120	103	100
Unidentified Scoter (*Melanitta* sp.)	40	40	20
Common Goldeneye (*Bucephala clangula*)	5	5	20
Red-breasted Merganser (*Mergus serrator*)	1	0	
Common Merganser (*Mergus merganser*)	14	9	80
Gaviiformes			
Gaviidae			
Unidentified Diver (*Gavia sp.*)	32	18	80
Podicipediformes			
Podicipedidae			
Great Crested Grebe (*Podiceps cristatus*)	9	9	60
Pelecaniformes			
Phalacrocoracidae			
Great Cormorant (*Phalacrocorax carbo*)	67	12	80
Charadriiformes			
Stercorariidae			
Unidentified Skua (*Stercorarius sp.*)	1	0	20
Laridae			
Little Gull (*Hydrocoloeus minutus*)	1	1	20
Black-headed Gull (*Larus ridibundus*)	1	0	20
Common Gull (*Larus canus*)	32	14	100
European Herring Gull (*Larus argentatus*)	523	249	100
Great Black-backed Gull (*Larus marinus*)	1	1	20
Unidentified Gull *(Larus sp.)*	20	20	20
Sternidae			
Unidentified Tern (*Sterna sp.*)	33	2	40
Alcidae			
Razorbill (*Alca torda*)	13	11	80
Black Guillemot (*Cepphus grylle*)	2	2	40

Results of coastal surveys

In the surveys, at least 57 species of water birds were encountered (Table 5-9). The bird groups with the most species were the Anseriformes (24 species), waders (16 species) and gulls (5 species).

The most abundant species were the Long-tailed Duck (counted a total of in excess of 80 000 birds), Common Goldeneye (approximately 11 500 birds) and European Herring Gull (approximately 11 900 birdss, furthermore, European Herring Gulls probably accounted for a substantial portion of the gulls which were not identified down to the species level). The most abundant groups of birds were the Anseriformes and gulls species belonging to these groups of species accounted for 83% and 16%, respectively, of all specimens counted. The species with the highest incidence (they were encountered in all of the times surveyed) were the Mallard, Goosander and European Herring Gull.

Table 5-9. Results of coastal surveys.

Species	Frequency %	Total birds counted s
Anseriformes		
Anatidae		
Mute Swan (*Cygnus olor*)	95	1 034
Tundra Swan (*Cygnus columbianus*)	14	28
Whooper Swan (*Cygnus cygnus*)	52	189
Unidentified Swan (*Cygnus sp.*)	10	40
Greater White-fronted Goose (*Anser albifrons*)	5	18
Unidentified Goose (*Anser sp.*)	5	350
Canada Goose (*Branta canadensis*)	5	7
Barnacle Goose (*Branta leucopsis*)	10	5
Common Shelduck (*Tadorna tadorna*)	33	75
Eurasian Wigeon (*Anas penelope*)	29	103
Gadwall (*Anas strepera*)	24	15
Eurasian Teal (*Anas crecca*)	38	67
Mallard (*Anas platyrhynchos*)	100	2 023
Northern Pintail (*Anas acuta*)	5	1
Garganey (*Anas querquedula*)	5	2
Northern Shoveler (*Anas clypeata*)	5	1
Tufted Duck (*Aythya fuligula*)	19	423
Greater Scaup (*Aythya marila*)	38	2 071
Common Eider (*Somateria mollissima*)	33	71
Long-tailed Duck (*Clangula hyemalis*)	86	80 657
Common Scoter (*Melanitta nigra*)	38	1 277
Velvet Scoter (*Melanitta fusca*)	43	924
Common Goldeneye (*Bucephala clangula*)	95	11 457
Smew (*Mergus albellus*)	14	4
Red-breasted Merganser (*Mergus serrator*)	62	226
Common Merganser (*Mergus merganser*)	100	326
Unidentified Merganser (*Mergus sp.*)	10	29
Gaviiformes		
Gaviidae		
Red-throated Loon (*Gavia stellata*)	5	1
Black-throated Loon (*Gavia arctica*)	14	11
Unidentified Loon (*Gavia sp.*)	5	1
Pedicipediformes		
Podicipedidae		
Great Crested Grebe (*Podiceps cristatus*)	86	504
Red-necked Grebe (*Podiceps grisegena*)	5	5
Horned Grebe (*Podiceps auritus*)	5	1
Pelecaniformes		
Phalacrocoracidae		
Great Cormorant (*Phalacrocorax carbo*)	71	496
Ciconiiformes		
Ardeidae		
Great Egret (*Casmerodius albus*)	5	1
Gray Heron (*Ardea cinerea*)	24	9
Accipitriformes		
Accipitridae		
White-tailed Eagle (*Haliaeetus albicilla*)	19	5
Charadriiformes		
Haematopodidae, Charadriidae, and Scolopacidae		

Species	Frequency %	Total birds counted s
Eurasian Oystercatcher (*Haematopus ostralegus*)	19	9
Little Ringed Plover (*Charadrius dubius*)	24	11
Common Ringed Plover (*Charadrius hiaticula*)	10	103
European Golden Plover (*Pluvialis apricaria*)	5	2
Gray Plover (*Pluvialis squatarola*)	5	1
Red Knot (*Calidris canutus*)	5	2
Sanderling (*Calidris alba*)	10	3
Little Stint (*Calidris minuta*)	5	4
Dunlin (*Calidris alpina*)	14	8
Ruff (*Philomachus pugnax*)	10	24
Unidentified Godwits (*Limosa sp.*)	5	3
Common Redshank (*Tringa totanus*)	5	1
Common Greenshank (*Tringa nebularia*)	10	16
Green Sandpiper (*Tringa ochropus*)	5	2
Wood Sandpiper (*Tringa glareola*)	10	5
Common Sandpiper (*Actitis hypoleucos*)	14	11
Laridae		
Little Gull (*Hydrocoloeus minutus*)	5	1
Black-headed Gull (*Larus ridibundus*)	76	1 323
Common Gull (*Larus canus*)	71	380
European Herring gull Gull *(Larus argentatus*)	100	11 870
Great Black-backed Gull (*Larus marinus*)	57	22
Unidentified Gull (*Larus sp.*)	24	6 530
Sternidae		
Common Tern (*Sterna hirundo*)	14	18
Unidentified Tern (*Sterna sp.*)	10	4
Alcidae		
Razorbill (*Alca torda*)	5	1

Overview of bird groups in coastal surveys and ship surveys

A total of 59 species of water birds from 7 orders and 13 families were encountered in the surveyed area (in ship surveys and coastal surveys). The encountered species may be classified into various categories according to the peculiarities of their living habits.

Species with a diet of aquatic vegetation and benthos

The most significant group of species in the surveyed area were diving ducks who prefer deeper areas of the sea. The Long-tailed Duck was the most abundant species, of which a maximum of 8 720 birds were counted in ship surveys and 17 700 birds were counted in coastal surveys in one survey (Table 5-10). The Long-tailed Duck was more abundant in the surveyed area from the second half of September until May, with individual birds still encountered as late as in the first half of June. Maximum encounters in both survey methods was in November. The maximum survey results of other species belonging to this group were 943 birds in the case of the Common Scoter (coastal survey), 338 birds in the case of the Velvet Scoter (coastal survey), and 130 birds in the case of the Common Eider (ship survey). The Common Scoter was more abundant from April until the first half of May, the Velvet Scoter was most abundant from February until the first half of April, and the Common Eider was most abundant in the first half of May.

Diving ducks preferring deeper sea areas were present in Lahepere Bay and in the bordering sea area approximately up to a depth line of 50 m. Only smaller rafts of Long-tailed Ducks were encountered at times in November even in the northern part of the surveyed area. In coastal surveys, 53% of Diving Ducks preferring deeper sea areas were counted in the 1st monitoring station. The biggest rafts of Long-tailed Ducks were on stopover in the region of the Pakri Shallow to the north-west of the 1st monitoring station (outside of the 2 km-wide zone surrounding the monitoring station). The database of irregular observations on biodiversity has recorded 20000 – 25000 stopovers of Long-tailed Ducks in the period October 20–21,2013 (*Eesti elurikkus 2013*). According to data from the coastal and ship surveys, Scoters preferred the eastern part of the Lahepere Bay, while Common Eiders preferred the north-western part.

Table 5-10 Maximum abundance of species with a diet of submerged aquatic vegetation.

Species	Coastal surveys	Ship surveys
	Maximum survey result, birds	Maximum survey result, birds
Swans		
Mute Swan (*Cygnus olor*)	132	
Tundra Swan (*Cygnus columbianus*)	22	
Whooper Swan (*Cygnus cygnus*)	41	
Unidentified Swan (*Cygnus sp.*)	20	
Dabbling ducks		
Common (*Tadorna tadorna*)	24	
Eurasian Wigeon (*Anas penelope*)	38	
Gadwall (*Anas strepera*)	7	
Eurasian Teal (*Anas crecca*)	22	
Mallard (*Anas platyrhynchos*)	267	
Northern Pintail (*Anas acuta*)	1	
Garganey (*Anas querquedula*)	2	
Northern Shoveler (*Anas clypeata*)	1	
Diving ducks		
Tufted Duck (*Aythya fuligula*)	332	
Greater Scaup (*Aythya marila*)	1414	
Common Goldeneye (*Bucephala clangula*)	2808	5
Diving ducks 2		
Common Eider (*Somateria molissima*)	33	130
Long-tailed Duck (*Clangula hyemalis*)	17 700	8 720
Common Scoter (*Melanitta nigra*)	943	204
Velvet Scoter (*Melanitta fusca*)	338	47
Unidentified Scoter (*Melanitta sp.*)		40

As regards diving ducks preferring sea areas of moderate depth, Common Goldeneyes, Greater Scaups and Tufted Ducks were present. In one survey, a maximum of 2 808 Common Goldeneyes, 1 414 Greater Scaups and 332 Tufted Ducks were counted. The Common Goldeneye was present in all coastal surveys except for the survey in July. The highest abundance of the species was t in the autumn from the second half of September until the first half of November. The Greater Scaup was present mainly in the autumn and achieved maximum abundance in the first half of November. The highest abundance of Tufted Ducks was in the second half of April. Different species preferred different areas of Lahepere Bay: the majority of Common Goldeneyes were counted atthe 5th counting station, the majority of Greater Scaups was counted at the 2nd counting station and the majority of Tufted Ducks was counted at the 4th counting station (Figure 5-34).

Swans and Dabbling Ducks feed by reaching down to the bottom and stop over in the shallow sea close to the coast. The most abundant swan was the Mute Swan (maximum of 132 birds), he most abundant Dabbling Ducks was the Mallard (267 birds). The highest abundance of swans was in autumn in the second half of October, and in winter in January to February. The highest abundance of Dabbling Ducks was in autumn from the second half of August until December. Swans, and particularly dabbling ducks preferred the sea area surrounding the 4th counting station as their stopover site.

Piscivorous species

Piscivorous species include Divers, Podiceps, Cormorant and Auks. The levels of abundance of piscivorous species were modest (Table 5-11). The most abundant species were the Cormorant (maximum coastal survey result of 198 birds), Great Crested Grebe (maximum coastal survey result of 197 birds) and Auk (maximum abundance estimate based on ship surveys of 100 birds) and Goosander (maximum coastal survey result of 63 birds). A maximum of 14 divers on stopover were counted in ship surveys. The survey results for Divers would require extrapolation: However, encountering them only outside of the main band of the survey did not permit that. In the case of the Black Guillemot, only one specimen on stopover was encountered, resulting in an abundance estimate of 10 birds.

Table 5-11. Maximum abundance of piscivorous species.

Species	Coastal surveys	Ship surveys	
	Maximum survey result, birds	Maximum survey result, birds	Maximum abundance assessment, birds
Mergansers			
Smew (*Mergus albellus*)	2		
Red-breasted Merganser (*Mergus serrator*)	39		
Common Merganser *(Mergus merganser)*	63	4	63
Unidentified Merganser (*Mergus sp.*)	15		
Loons			
Red-throated Loon (*Gavia stellata*)	1		
Black-throated Loon (*Gavia arctica*)	8		
Unidentified Loon (*Gavia sp.*)	1	14	
Grebes			
Great Crested Grebe (*Podiceps cristatus*)	197	7	40
Red-necked Grebe (*Podiceps grisegena*)	5		
Horned Grebe (*Podiceps auritus*)	1		
Cormorant			
Great Cormorant (*Phalacrocorax carbo*)	198	7	40
Auks			
Razorbill (*Alca torda*)	1	7	100
Black Guillemot (*Cepphus grylle*)		1	10

The highest abundance of Cormorants was from the second half of August until the first half of September, the highest abundance of Great Crested Grebes was in the first half of October. The highest number of Auks and Divers were counted in the ship survey conducted in the second half of October.

The Auk was the most piscivorous species encountered offshore, withmost specimens being encountered in the deep northern part of the survey area. Divers were encountered across the entire survey area, the species was more frequent in the southern part, in sea of up to 50 m in depth. Cormorants, Grebes and Mergansers were only present in the southern part. In coastal surveys, more than three fourths of the Cormorants were counted at the 1st counting station and more than a half of the Grebes from the 4th counting station, whereas the distribution of Mergansers was relatively consistent.

Pelagic species

The so-called pelagic species includes Gulls, Terns and Skuas. The most abundant species of Gull was the European Herring Gull: in coastal surveys a maximum of 2 579 specimens were counted, in ship surveys a maximum of 198 birds, and the abundance estimate is 548 birds (Table 5-12). In coastal surveys, the second most abundant species was the Black-headed Gull (maximum survey result of 400 birds). The proportion of Gulls which were not identified down to the species level was high (a maximum of 2 900 birds). A maximum of 97 Common Gulls were counted in coastal surveys, and 14 specimens in ship surveys (the maximum abundance estimate based on ship surveys is 179 birds). Terns, and especially Skuas, were low in abundance: a maximum of 24 Terns were counted in ship surveys and a maximum of 16 Terns in coastal surveys. Only one Skua was encountered in ship surveys.

The European Herring Gull was present in all surveys, maximum abundance of the species was in the first half of September. The combined abundance of European Herring Gulls and undetermined Gulls was high in coastal surveys from July to December, and in February. The Black-headed Gull was absent in the winter. The species was more abundant in the second half of August, first half of October and first half of April.

European Herring Gulls were diffusely distributed across the entire survey area. In coastal surveys, most of the Gulls had converged in the vicinity of the 4th counting station, which contained in excess of 70% of the European Herring Gulls, in excess of 60% of the Black-headed Gulls and in excess of 70% of total Gulls counted.

Table 5-12 Maximum abundance of pelagic species.

Species	Coastal surveys	Ship surveys	
	Maximum survey result, birds	Maximum survey result, birds	Maximum abundance assessment, birds.
Skuas			
Unidentified Skua (*Stercorarius sp.*)		1	
Gulls			
Little Gull (*Hydrocoloeus minutus*)	1	1	
Black-headed Gull (*Larus ridibundus*)	400	1	
Common Gull (*Larus canus*)	97	14	179
European Herring Gull (*Larus argentatus*)	2 579	198	548
Great Black-backed Gull (*Larus marinus*)	5	1	
Unidentified Gull (*Larus sp.*)	2 900	20	
Terns			
Common Tern (*Sterna hirundo*)	16		
Unidentified Tern (*Sterna sp.*)	2	24	

Coastal species

Species associated with the coast are Anser and Branta, Ardea and Waders. The representatives of the aforementioned bird groups were low in terms of numbers and incidence. Regarding Geese, an event worth noting is the encounter of 350 specimens in the second half of March near the third observation point (Table 5-13). Waders were encountered from the second half of April until September, they were highest in abundance in August. Most Waders were found around the 4th counting station.

Table 5-13. Maximum abundance levels of coastal species.

Species	Coastal surveys
	Maximum survey result, birds
Geese	
Greater White-fronted Goose (*Anser albifrons*)	18
Unidentified Goose (*Anser sp.*)	350
Canada Goose (*Branta canadensis*)	7
Barnacle Goose (*Branta leucopsis*)	3
Herons	
Great Egret (*Casmerodius albus*)	1
grayGray Heron (*Ardea cinerea*)	3
Haematopodidae, Charadriidae and Scolopacidae	
Eurasian Oystercatcher (*Haematopus ostralegus*)	6
Little Ringed Plover (*Charadrius dubius*)	4
Common Ringed Plover (*Charadrius hiaticula*)	85
European Golden Plover (*Pluvialis apricaria*)	2
Gray Plover (*Pluvialis squatarola*)	1
Red Knot (*Calidris canutus*)	2
Sanderling (*Calidris alba*)	2
Llittle Stint (*Calidris minuta*)	4
Dunlin (*Calidris alpina*)	4
Ruff (*Philomachus pugnax*)	16
Unidentified Godwits (*Limosa sp.*)	3
Common Redshank (*Tringa totanus*)	1
Common Greenshank (*Tringa nebularia*)	11
Green Sandpiper (*Tringa ochropus*)	2
Wood Sandpiper (*Tringa glareola*)	4
Common Sandpiper (*Actitis hypoleucos*)	8

Bird protection value of the area for the non-breeding birds

As regards the species encountered in the coastal and ship surveys, the following are included in Annex I to the Birds Directive: Whooper Swan, Tundra Swan, Barnacle Goose, Smew, Black-throated Diver, Red-throated Diver, Horned Grebe, Great Egret, White-tailed Eagle, Common Redshank, Ruff, Wood Sandpiper, Little Gull and Common Tern. White-tailed Eagle and Ruff are Category I protected bird species[1]; Black-throated Diver, Horned Grebe, Tundra Swan, Whooper Swan, Smew, Little Gull, Razorbill and Black Guillemot are Category II protected bird species; Red-throated Diver, Red-necked Grebe, Barnacle Goose, Common Shelduck, Velvet Scoter, Common Ringed Plover and Little Ringed Plover, Golden Plover, Common Redshank, Common Greenshank, Wood Sandpiper and Common Tern are Category III protected bird species. However, several of the aforementioned species were found in very low numbers.

A common criterion of international importance in the case of migratory water birds stopping over is that at least 1% of the flyway population of one species is supported. The survey area is of international importance for Long-tailed Ducks for which the new 1% criterion of the flyway population is 16 000 birds (*Wetlands International 2013*). Species occurring in numbers exceeding criteria of domestic importance (*Estonian Ornithological Society 2013*) were the Common Goldeneye, Tufted Duck and Great Crested Grebe.

1 There are three protective categories for Estonian species according to the Nature Conservation Act with Cat. I being the highest.

Table 5-14. Bird protection value of the area.

Species	Maximum abundance, sp.	Criterion for area of international importance, spec. (Wetlands International 2013)	Criterion for area of local importance, spec. (Estonian Ornithological Society 2013)
Long-tailed Duck (*Clangula hyemalis*)	17 700	16 000	
Common Goldeneye (*Bucephala clangula*)	2 808		1 000
Greater Scaup (*Aythya marila*)	1 414		1 000

Summary of water bird surveys

A total of 86 different species of birds were recorded in addition to three families Divers, Terns and Skuas, representatives of which were not identified down to the species level.

A total of 39 species of birds was recorded through the monitoring of nesting birds,. At times, the density was relatively high. In the coastal area, the nesting of Common Shelducks and Goosander was recorded. Both these species build sheltered nests. Also the nesting of the Gadwall, Common Sandpiper, Common Pied Oystercatcher, Little Ringed Plover, Common Gull and Arctic Tern was noted.

Through ship and coastal monitoring, a total of 59 species of water birds was counted. The bird groups with the most species were the Anseriformes (24 species), Waders (16 species) and Gulls (5 species). Of the species encountered, 14 are included in Annex I of the Birds Directive – two species are animal species in Category I of protection, eight species are included in Category II of protection and 12 species are included in Category III of protection. However, several of the species under the Birds Directive and protection categories were found in very low numbers. The most numerous species were the Long-tailed Duck (maximum survey result was 17 700 birds), Common Goldeneye (approximately 2 800 birds) and European Herring Gull (approximately 2 600 birds). Anseriformes accounted for 83% of all birds counted in the coastal survey and 97% of all counted birds in counting from ship. Lahepere Bay is of international importance (supports at least 1% of the flyway population) for the Long-tailed Duck, of domestic importance for the Common Goldeneye and Tufted Duck (a maximum of approximately 1 400 birds).

5.1.12 Marine mammals

Three species of marine mammals inhabit the Baltic Sea – the gray seal (*Halichoerus grypus*), ringed seal (*Pusa hispida botnica*), and harbor porpoise (*Phocoena phocoena*) (*Ramboll 2013e*). The estimated abundance of the gray seal in the Gulf of Finland is 800 specimens and there are estimated to be 200300 ringed seals(-*Jüssi 2011*). Both species may also be encountered in Lahepere Bay (*Ramboll 2013e*). The harbour porpoise on the other hand mainly inhabits the southern part of the Baltic Sea and very rarely comes to Estonian waters, including the Gulf of Finland. The gray seal (*Halicoerus grypus)*, the Baltic subspecies of the ringed seal (*Pusa hispida botnica)* and harbor porpoise (*Phocoena phocoena)* are included in the lists of species of Annexes II and V of the EU Habitats Directive. Annex II lists those species that require designation of special areas of conservation (Natura 2000 sites). The species covered by Annex V are those whose taking from the wild (hunting, collecting, etc.) requires regulation.

The most demanding period during the annual cycle of gray seals and ringed seals is the spring. They give birth in February–March onto sea ice or an islet (only gray seals). The nursing period is 5–7 weeks, after which the pups are weaned by the mothers. After the pupping period the seals undergo moulting, which among ringed seals mainly takes place in April–May and among gray seals in May–June. During the pupping and moulting periods seals are relatively immobile, mainly remaining on dry land while moulting. Ringed seals show reasonably high place fidelity, while gray seals can move long distances depending on the season. In the summer and autumn gray seals disperse over extensive areas when looking for good feeding grounds, including offshore areas and sites further down south. (*RKTL 2012*)

The following provides a more detailed description of species and their abundance.

Gray seal

The gray seal is the largest mammal of the Baltic Sea. The seal inhabits areas around islands and islets and is stationary. Gray seals are common across the Baltic Sea, as has also been confirmed by rediscovering marked specimens.

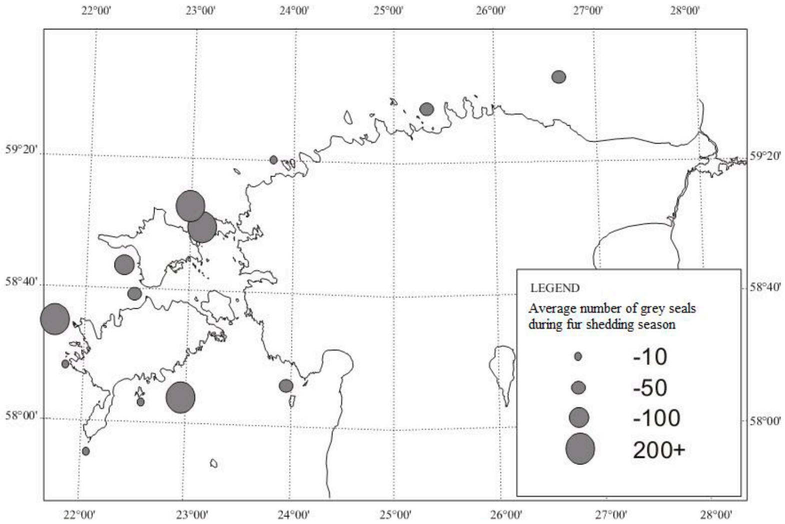


Figure 5–36. Distribution and abundance of gray seals during the fur shedding season in the Estonian coastal sea (*Jüssi & Jüssi, 2000*).

The number of gray seals surveyed in Estonian waters has usually ranged from 2 000 to 4 000 specimens in the most recent decade (*Ramboll 2013e*). Most of the animals were counted in the regions of the West Estonian Archipelago, Väinameri and the Gulf of Riga (Figure 5–36). The abundance of the gray seal in the Gulf of Finland is estimated to be 800 specimens, a high proportion of which inhabit Finnish waters. According to information available, gray seals regularly inhabit two areas of the Gulf of Finland – Uhtju islands to the north of Kunda, and Vahekari in the Malusi islands in the Gulf of Kolga (Figure 5–36). The third area with a higher abundance of gray seals is to the west of the Pakri islands the region of the Krassi Island, where the gray seal monitoring area is also located. The gray seal is included in Estonia›s nature conservation protection category II in and is also under protection on the basis of Annex II and IV of the Habitats Directive. Under regulation No 78 of the Minister of the Environment on December 20, 2005, several permanent habitats of gray seals were designated for protection in the counties of Harju, Saare and Hiiu.

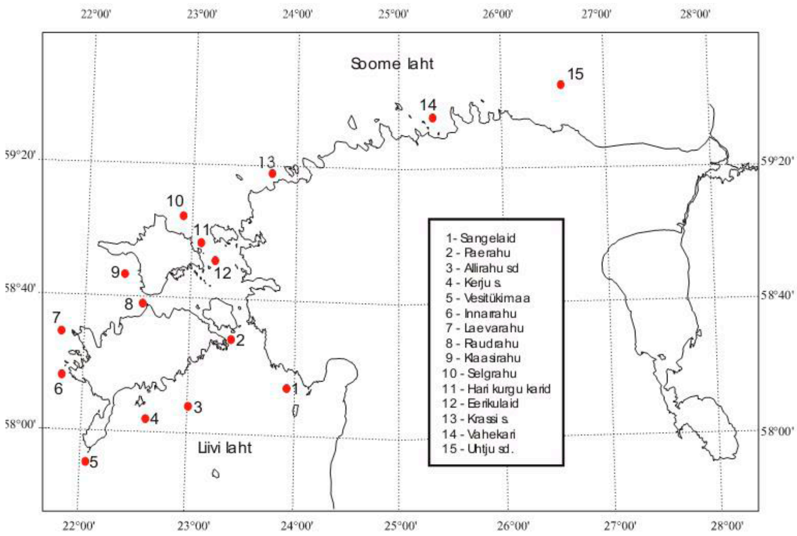


Figure 5-37. Location of gray seal haul-outs in Estonian coastal sea (*Jüssi & Jüssi, 2000*).

Krassi Island and the shallow sea area surrounding it (Krassgrund) is also an area permanently inhabited by gray seals and, at a distance of 21 km from the planned gas pipeline route corridor and 17 km from the Pakrineeme alternative route (Figure 5-37), is the closest such areato Lahepere Bay,. In the course of surveys taken during the fur shedding season on Krassi Island in 2011, up to 15 specimens were counted (Jüssi, 2011). In 2006, a permanent habitat of 80.2 ha was established on Krassi Island for the protection of gray seals (regulation No 78 of the Minister of the Environment on December 20, 2005 titled "Designation of permanent habitats of the gray seal and ringed seal for protection and rules of protection"). As Krassi Natura area, the area of permanent habitat is also part of the international Natura 2000 network.

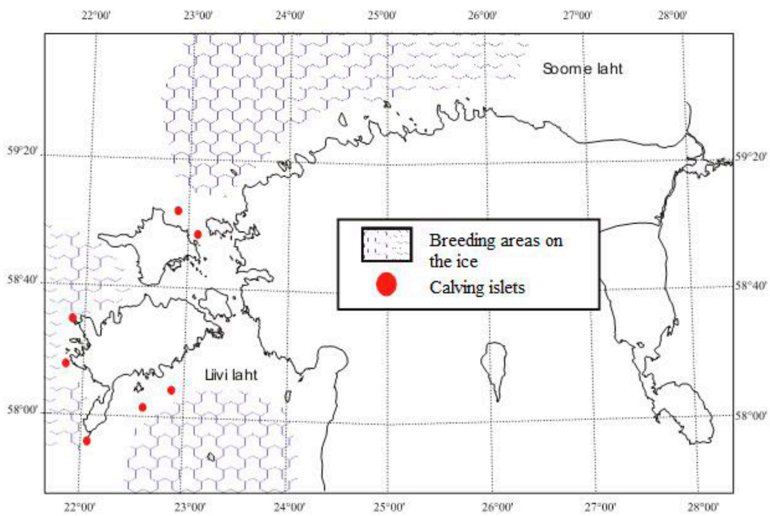


Figure 5-38. Breeding grounds of gray seals on ice and islands where they give birth (Jüssi & Jüssi 2000).

Lahepere Bay does not contain small islands or reefs suitable for seals to use as haul-out areas and for calving on land. In winters with prolonged ice cover, gray seals give birth on the sea ice and do not converge on the islands (Figure 5-38). The counting of seals giving birth on ice is difficult, therefore no accurate data are available on calving grounds. From this, it can be assumed that as long as there is ice, gray seals may also give birth in the area of Lahepere Bay. Another assumption that can be made is that seals are present in the coastal sea around Pakri Peninsula and Lahepere Bay also in the summer and autumn. However, considering the survey data and ice conditions of the area, where the sea freezes relatively late and the ice cover is not particularly constant, the abundance of the gray seal in the region is probably relatively low (*Ramboll 2013e*).

Ringed seal and harbor porpoise

Small cetaceans and classified as Critically Endangered (CE), harbor porpoises are found infrequently in the Gulf of Finland (*Environmental administration 2013*). The occurrence of harbor porpoises in the Gulf of Finland was studied in the Static Acoustic Monitoring of the Baltic Sea Harbor Porpoise (*SAMBAH*) project in 2011–2013 (*www.sambah.org*). During those two years, no harbor porpoises were observed in the Gulf of Finland, but they were found in southwestern parts of the Archipelago Sea. In the 2010 Red List of Finnish Species (*Rassi 2010*) the harbor porpoise was classified as Regionally Extinct (RE), but in the Baltic Marine Environment Protection Commission (HELCOM) Red List the subpopulation (estimated 600 individuals) is the main basin of the Baltic Sea was classified as Critically Endangered (CE) (*HELCOM 2013, Environmental administration 2013*). The harbor porpoise is also included in the lists of species of Annexes II and IV to the EU Habitats Directive.

The population of the Baltic subspecies of the ringed seal is around 10,000 individuals (*RKTL 2012*). Around 75% of all of these are found in the Bothnian Bay and around 15% in eastern Gulf of Riga. The ringed sea population of the Archipelago Seal is estimated at 200–300 and eastern Gulf of Finland 50–150 individuals (*RKTL 2012, Ahola 2014*). Of the ringed seals found in the Gulf of Finland, most breed on the Russian side where the ice situation is more favorable during the pupping period. The Gulf of Finland population has undergone a strong decrease (*Kunnasranta 2010*). The ringed seal is a game species, but no hunting permits have been granted since 1988. In Estonia the ringed seal is protected under the Nature Conservation Act (*HELCOM 2013*). In the Red List of Finnish Species the ringed seal is classified as Near Threatened (NT), while the HELCOM Red List classifies the subspecies as Vulnerable (VU) (*Rassi 2010, HELCOM 2013*) and the Estonian Red List of threatened species as Endangered (EN) (*Eesti punane raamat 2008*).

The primary range of the ringed seal in Estonia is in the eastern part of the Gulf of Finland and in the West Estonian archipelago. The harbor porpoise, on the other hand, mainly inhabits the southern part of the Baltic Sea. As both species occur only rarely in Lahepere Bay and its close vicinity, the impact of the Balticconnector pipe line can be estimated as insignificant for these two species.

Gray seals are the most numerous marine mammals in the Baltic Sea, ringed seals are estimated to be fewer in number and the harbor porpoise is mostly a rare incidental visitor in Estonian waters.

The haul-out area and survey area of the gray seal closest to Lahepere Bay is Krassi Island, where a permanent habitat of the gray seal was established in 2006 and which is also part of the Natura 2000 network.

Ringed seals and harbor porpoises in the Lahepere Bay region is an occurrence that is mostly of a rare and incidental nature.

5.1.13 Noise

Airborne noise in the Gulf of Finland is mostly caused by vessel traffic and focuses on areas along the main fairways. In addition, noise is caused by construction and military activity. As well as anthropogenic sounds, the soundscape of the area also features natural sounds such as waves, wind, storms and ice movement.

There are no studies available concerning the levels of airborne sound in the Gulf of Finland, while some studies have been conducted on underwater noise in the Baltic Sea. The purpose of the EU-funded LIFE+ project Baltic Sea Information on the Acoustic Soundscape (BIAS) is to measure the levels of anthropogenic and natural underwater noise around the Baltic Sea at different times of the year in 2014–2016 (*BIAS 2014*). The project has 40 measurement stations around the Baltic Sea, and a sound map covering the entire sea will be produced on the basis of the findings.

Underwater noise in the Baltic Sea is caused particularly by vessel traffic and various types of underwater work such as dredging and blasting. Seismic studies may also generate noise. Ice movement, icebreaking and vessel traffic through ice cause a lot of noise in the Baltic Sea (*BIAS 2014*). In addition to ice movement, other natural sources such as wind, rain and waves generate sounds and may be carried underneath the surface. The noise caused by a storm may even drown out the sounds of ship engines. (*BIAS 2014*)

Underwater sound is composed of pressure and particle motion. The lowest frequencies of the marine soundscape (0.1–5 Hz) result from the Earth's seismic activity. Sounds in the 5–20 Hz range arise from wave turbulence. Wind mainly generates ambient noise exceeding 1 kHz. Vessel traffic is the most important source of sound in the 20200 Hz range in the soundscape of the Baltic Sea near fairways. Events in the atmosphere generate sounds in the 200100,000 Hz range. Sounds exceeding 100 kHz are caused by thermal motion.

Oceanic underwater ambient noise spectral curves were originally compiled by Wenz (*Wenz 1962*). Traffic noise is the cumulative effect of all distant shipping from the surrounding marine area. It generates a stationary maximum in ambient noise spectra, which may mask noise from other sources.

The ambient noise level within the 1/3 octave bands frequencies 63 and 125 Hz (center frequency) are suggested in Descriptor 11 (Noise/Energy) of the Marine Strategy Framework Directive 2008/56/EC to use for estimation of the ambient noise trends. The Wenz curve depicted noise levels are 90 dB and 85 dB (re 1 µPa per 1 Hz) for these two center frequencies, respectively. Average broadband ambient noise levels of 111–117 dB (re 1 µPa per 1Hz) close to ship lanes near Norra Midsjöbanken (around 40 km east of Öland) are reported in the study by Swedish Defence Research Agency (*FOI 2012*). Preliminary analyses of the BIAS LIFE+ project measurements indicate that in January 2014 the mean ambient noise levels at the 1/3 center frequencies may be lower as compared to the Wenz curves results (Table 5-15). On the Estonian side hydrophones in the Gulf of Finland are deployed at water depths deeper than 60 m. The results presented in the table show clearly that the ambient noise level is directly linked with the rate of vessel traffic.

Most of the Baltic Sea marine area is impacted at least by a level of noise that has been estimated to mask the communication of animals (Figure 5-39, *HELCOM 2010*).

Table 5-15. Average ambient noise Sound Pressure Levels in the Gulf of Finland according to Wenz curves and BIAS project measurements, dB (± 10 dB) re 1 μPa.

	63 Hz mid frequency	125 Hz mid frequency
Wenz (low traffic)	65	65
Wenz (moderate traffic)	73	73
BIAS Gulf of Finland (low)	70	75
BIAS Gulf of Finland (moderate)	78	84

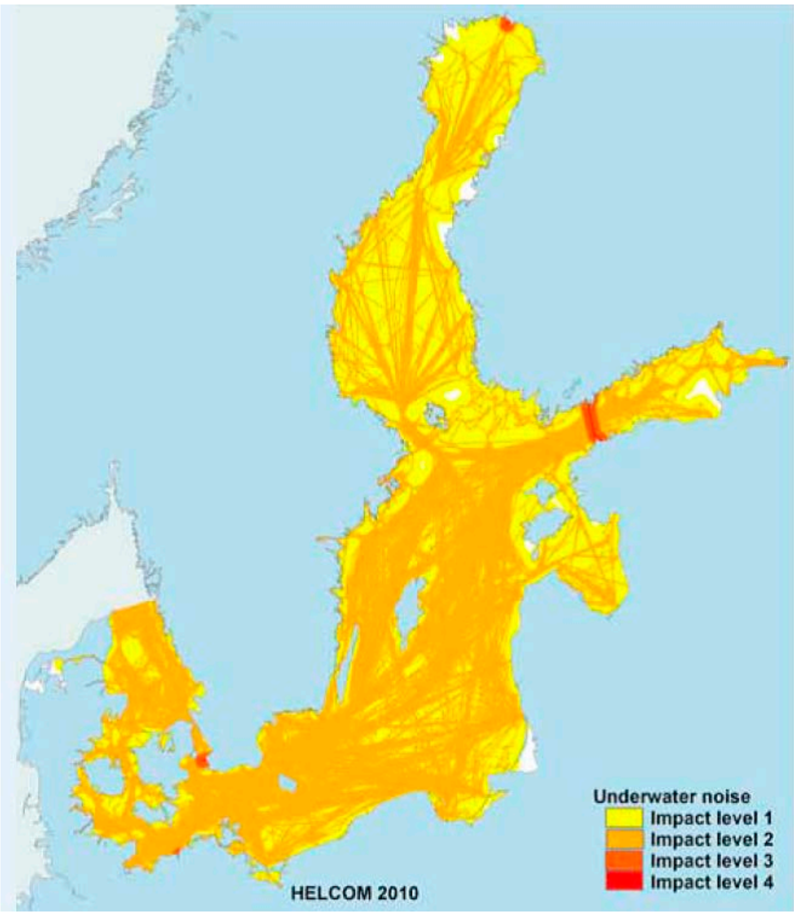


Figure 5-39. Distribution of underwater noise in the Baltic Sea in 2003–2007. Impact level 1 indicates that the noise is audible to biota; level 2 indicates that masking of communications occurs; level 3 indicates an avoidance reaction; level 4 indicates physiological impacts (*HELCOM 2010*).

5.1.14 Air quality

Emissions into air from shipping are generated in the combustion process of fuel used in ship engines. Ship combustion processes produce nitrogen oxides (NO_x), sulfur dioxides (SO_2), particulate emissions and carbon dioxide (CO_2).

Baltic Sea shipping emissions into the air in 2012 are shown in the table below (Table 5-16). Also shown in the table are emissions from Estonian waterborne traffic in the exclusive economic zone of Estonia in 2012 (international traffic, domestic traffic). Waterborne traffic is one of the smallest contributors to total traffic emissions in

Estonia as regards sulfur dioxide, accounting for only 1% of total sulfur dioxide emissions. Of total traffic emissions, waterborne traffic accounted for 0.9% of volatile organic compounds (VOC) and 0.4% of carbon monoxide emissions in 2012 *(Estonian Environment Agency 2014: "Eestis välisõhku eraldunud saasteainete heitkogused aastail 1990–2012")*. Cargo ships generate considerably higher sulfur dioxide and nitrogen oxide emissions than passenger vessels. (*VTT 2012*)

Table 5-16. Emissions into the air from Baltic Sea shipping and Estonian waterborne transport (tonnes per year). (*VTT 2012, Estonian Environment Agency 2014)*

	Nitrogen oxides	Sulfur dioxide	Particulate matter	Carbon dioxide
	t	t	t	t
Baltic Sea (in 2012)	370 000	84 000	23 000	19 000 000
Estonian EEZ (in 2012)	17 000	4 400	1 000	2 100*

* Carbon monoxide

The MARPOL Convention regulates global limits on shipping emissions. These limits are more stringent than in global traffic in the sulfur emission control areas (SECAs). In Northern Europe, a SECA is formed by the Baltic Sea, North Sea and the English Channel. The revised air pollution annex to the MARPOL Convention entered into force internationally on July 1, 2010, reducing the maximum sulfur content of marine fuels in the SECA from 1.5% to 1.0%. A further reduction in fuel sulfur content comes into effect in 2015, reducing the limit to a maximum of 0.1% *(Finnish Shipowners' Association 2014.)*

Nitrogen oxide emissions from shipping will be restricted gradually in accordance with the air pollution annex to the MARPOL Convention. The revised Annex VI contains the global requirement that marine diesel engines installed on a ship constructed on or after January 1, 2011 must achieve a 15% reduction in the level of nitrogen oxide (NOx) emissions compared with the legislation currently in force. Annex VI also provides regulations on the establishment of Nitrogen Oxide Emission Control Areas (NECA), requiring that vessels constructed on or after January 1, 2016 passing through NECAs must emit 80% less nitrogen oxides in comparison with the current situation. Furthermore, vessels constructed on or after January 1, 1990 but before January 1, 2000, which have so far not been subject to regulation, must meet the current permitted level of nitrogen dioxide emissions (*Ramboll 2013*).

Efforts are being made to reduce particulate emissions from shipping by lowering the sulfur content of fuels. *(Finnish Shipowners' Association 2014)*. In the Baltic Sea, shipping emissions into the air were cut in 2012 from the level seen the year earlier. As regards large ships, the reduction in emissions of nitrogen oxides was 5.7%, sulfur oxides 5.5%, fine particulate matter 5.3% and carbon dioxide 5.5%. There has been a steady decrease in particulate and sulfur emissions from shipping since 2010 due to the stricter emission limits under the MARPOL Convention in the SECAs and the EU Sulfur Directive, which sets the fuel sulfur content limit of 1.0% during voyages and 0.1% while at berth in ports (*Jalkanen 2013*).

The quality of air in the vicinity of the area affected by the project is good as regards human health. The average monthly nitrogen dioxide (NO_2) levels at the coastal measurement station of Lahemaa, Estonia, were in the 1.5–7 μ/m³ range in 2010. The annual mean guideline air quality value for nitrogen dioxide is 40 μ/m³. Nitrogen oxide emissions from shipping are a major contributor towards eutrophication of the Baltic Sea. It has been estimated that in 2007, more than 6% of the total nitrogen concentration of the Baltic Sea was produced by shipping (*Ramboll 2013*).

5.1.15 Vessel traffic

There is heavy vessel traffic in the region where the gas pipeline is planned. West-east transit ship traffic between the open sea part of the Baltic Sea and the Gulf of Finland accounts for most of this traffic. According to data from 2012, the number of ships entering and exiting the Gulf of Finland was approximately 41 000 ships per year (*HELCOM 2014*). Vessel traffic is monitored using the GOFREP ship reporting system, with centers in Tallinn, Helsinki and St. Petersburg. GOFREP is mandatory for vessels of a gross tonnage of 300 GT and over.

Vessel traffic in the region was analyzed on the basis of AIS (Automatic Identification System) data from 2012 by Ramboll (*2013*). Since the end of 2004, ships (except naval ships) of agross tonnage of 300 GT and over must carry AIS transponders on a mandatory basis under a decision by the International Maritime Organization (IMO). In recent years, even smaller ships have increasingly started to join the AIS system,but they are still under no obligation to do so. The vessel traffic intensity shown below has been described based on studies by Ramboll (*2013*).

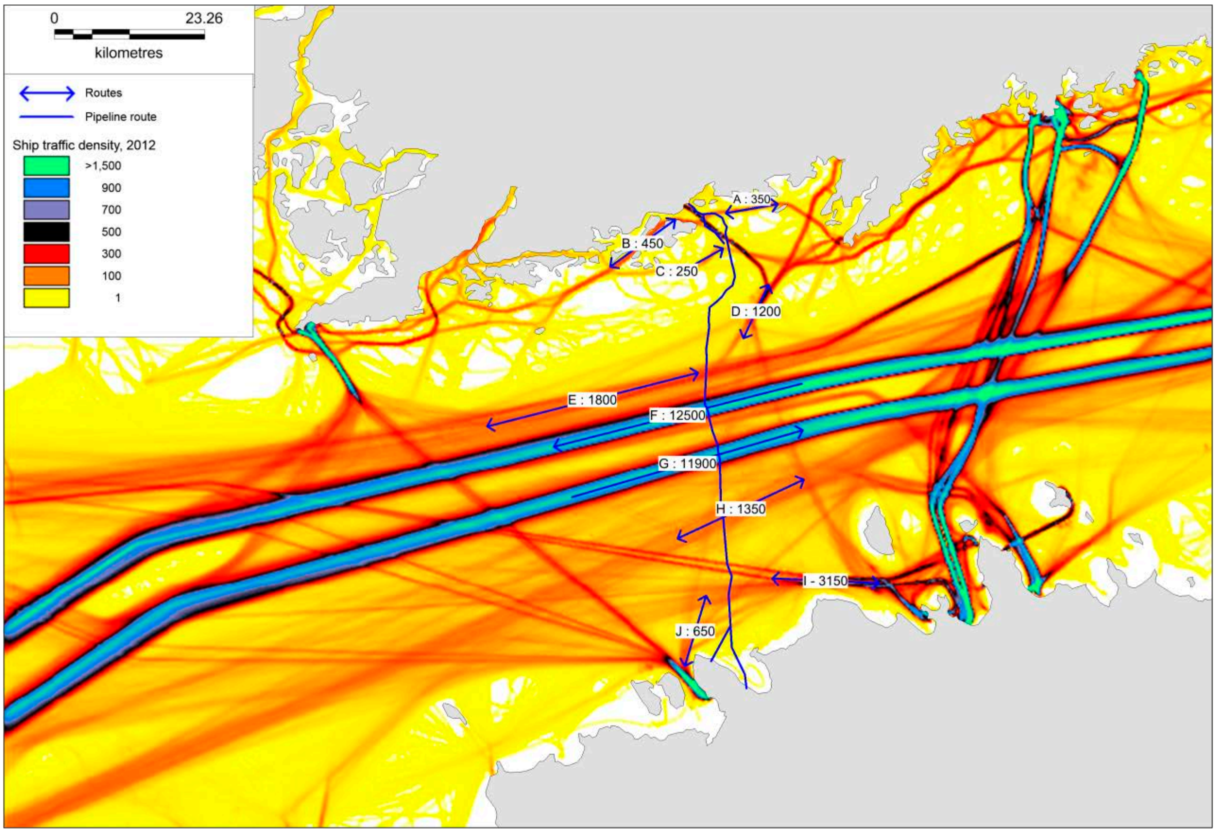


Figure 5-40. Vessel traffic intensity in the region of the proposed pipeline route according to AIS data from 2012 *(Ramboll 2013)*. The blue line shows the route of the gas pipeline proposed for construction. Select sections are indicated as blue arrows (direction of traffic). The color scale represents vessel traffic intensity, i.e. how many times ships were counted in each grid cell.

Figure 5-40 shows vessel traffic intensity map of the region. The area with the most intense vessel traffic is concentrated in two corridors with a zone of separation, representing traffic entering the Gulf of Finland (southern) and exiting from it (northern). Intense vessel traffic also occurs between Tallinn and Helsinki, and in the entry and exit lanes to several harbors (Muuga, Paldiski, Hanko).

Table 5-17 Number of ships passing through the sections of shipping lanes under observation (see Figure 5-40) in 2012 (*Ramboll 2013*).

Route	Crossings
A	350
B	450
C	250
D	1 200
E	1 800
F	12 500
G	11 900
H	1 350
I	3 150
J	650

Ramboll (2013) has identified ten sections with the highest vessel traffic intensity (indicated as blue arrows in Figure 5-40) crossing the planned gas pipeline route or passing by it at a close distance. Table 5 17 shows the number of ships passing these sections in 2012. The heaviest traffic crossing the planned gas pipeline route is the shipping lane along the Gulf of Finland (entry into the gulf is represented by G and exit from the gulf by F in Figure 5-40). In addition to the aforementioned primary shipping lane, considerable traffic along the Gulf of Finland occurs both to the north (E) and to the south (H) of the latter. Traffic from and to Muuga Harbor and the harbors of Tallinn and Kopli Bay (I) converges with lane H, and traffic from and to Ingå and other Finnish harbors (D) converges with lane E. On Estonian coast, vessel traffic from and to the harbor of Paldiski is also clearly distinguishable (J). There are multiple sections with heavy small boat traffic (A, B, C) in the coastal sea of Finland. For instance, the Hanko Helsinki waterway, one of the small boat routes with the most intense vessel traffic in Finland, runs along the coastline. As many small vessels probably do not carry AIS, vessel traffic in the coastal sea there is more likely to be underestimated in Figure 5-40.

Traffic intensity near the Estonian coastline is lower compared to that of Finland, and the shipping lane running along the coast is not so well defined. This may be related to the fact that, unlike in Finland, ships have not been concentrated into a narrow waterway. Since small boats moving in the coastal sea probably do not often have the AIS system, traffic intensity can be understated. A good example is Lohusalu, which is home to the only small boat harbor in close proximity to the gas pipeline route on the Estonian coast, and which, according to data from the Estonian Maritime Administration was visited by 550 vessels in 2012 (*Estonian Maritime Administration 2014*).

5.1.16 Military areas

The Estonian navy has practice areas 5 km from the planned natural gas pipeline route. According to data from the Estonian Ministry of Defence, it can be stated that the route of the planned gas pipe does not cross any existing or planned navy practice areas.

There are areas used by the Finnish Defence Forces near the planned natural gas pipeline route on the Finnish side (Figure 5-41). The route passes through the Upinniemi restricted area and Upinniemi firing range. The purpose of the restricted areas is to contribute towards the safeguarding of Finland's territorial integrity. Special regulations apply to restricted areas; activities not allowed in a restricted area without permission include scuba diving or other underwater activity which

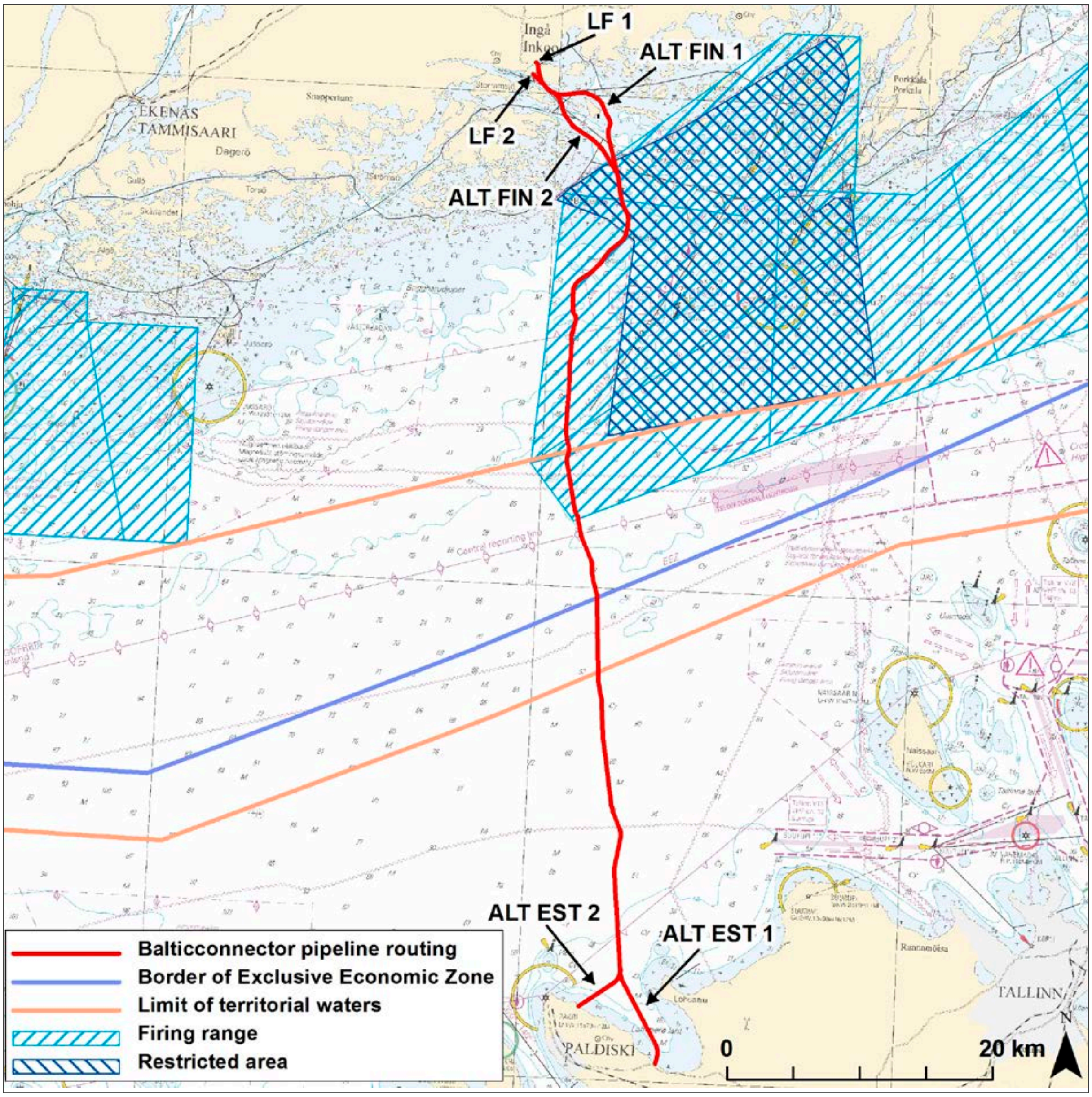


Figure 5-41. Military areas of Finnish Defence Forces near the proposed natural gas pipeline route.

does not normally form part of navigation, such as anchoring of buoys at the bottom, anchoring a vessel other than a pleasure craft, excavation and deposition of benthic material, cable-laying or use of sonars. Seabed exploration and mapping are also prohibited without permission. Firing of weapons regularly takes place in the firing range of the Finnish Defence Forces, during which strict restrictions on activities apply.

5.1.17 Underwater monuments of cultural heritage

In the Gulf of Finland, the monuments of cultural heritage of material relevance to the project mainly consist of underwater shipwrecks and other marine archaeology sites. Wrecks can be found particularly along fairways and close to harbors. Other archaeological sites can usually be found in shallow areas that were once above the sea level.

The underwater cultural heritage found in the Finnish and Estonian waters has been surveyed in conjunction with the Balticconnector project on the basis of previous inventory data (incl. *National Board of Antiquities 2014*) and the first stages of the underwater archaeological inventories based on side scan sonar data (*SubZone Oy 2014 and 2015*).

In Estonia, the Heritage Conservation Act (*Muinsuskaitseseadus*, RT I, June 29, 2014, 42) regulates underwater monuments. Pursuant to Section 3 (2) 6) of the Heritage Conservation Act, immovable monuments may include underwater submerged watercraft, aircraft and other vehicles, parts or bodies thereof together with the underneath bottom of water body and cargo or other content. Pursuant to Section 3^1 (1) of the Heritage Conservation Act, underwater monuments located in internal and transboundary water bodies, inland and territorial seas which do not have an owner or the owner of which cannot be established belong to the state. Pursuant to § 3^1 (2) of the Heritage Conservation Act, underwater monuments are administered by the National Heritage Board. Pursuant to Section 13 of the Heritage Conservation Act, underwater monuments shall be entered on the navigation map by the Maritime Administration in co-operation with the National Heritage Board. Pursuant to Section 14 (1) of the Heritage Conservation Act, underwater monuments may be marked with appropriate signs. The Heritage Conservation Act regulates diving to underwater monuments.

Pursuant to Section 24^1 of the Heritage Conservation Act, in addition to the restrictions specified in Sections 23 and 24 of this Act it is prohibited to anchor, trawl, dredge and dump solid substances within underwater monuments and the protected zones thereof. The Heritage Conservation Act does not regulate the protection zone of underwater objects of cultural heritage but the National Heritage Board estimates the protection zone of underwater monuments of cultural heritage to be typically two cable lengths (one cable length is equal to 1/10 nautical miles or 185.2 m) (*according to the March 12, 2014 letter No 1.01-7/358-1 from the National Heritage Board*).

According to the Wreck Register database of the National Registry of Cultural Monuments and the Hydrography Information System of the Estonian Maritime Administration, 11 known shipwrecks are located in the project area (within 5 km of the planned route of the natural gas pipeline) off the coast of Estonia.

According to the the side scan sonar survey performed by MMT in 2006 and 2014, there are previously known 11 wrecks and one possible wreck, which is not confirmed within a distance of 3 nautical miles of the pipeline (*SubZone 2015*). One possible wreck is marked on sea chart F20 (No 12 in Table 5-18 and Figure 5-42), but not confirmed. Shipwrecks are shown in Table 5-18 and Figure 5-42.

Table 5-18. Shipwrecks which are located in the project area (within 5 km of the route of the Balticconnector natural gas pipeline).

No. on figure	Coordinates in L-EST system		Depth	Name in information system of Estonian Maritime Administration	No. in information HIS system	Approximate distance from the gas pipeline, meters
	X	Y				
1	6584331.48	501129.40	46.38	unnamed 63	46	5 000
2	6586256.33	510960.61	7.02	Jossif Stalin	65	3 430
3	6586369.95	510984.64	6.54	Jossif Stalin fragment	70	3 430
4	6590270.50	510380.72	39.02	Fennia	39	3 250
5	6589968.34	506282.84	52.51	unnamed 178	52	850
6	6590408.12	503372.96	64.37	F112600	64	3 670
7	6591980.17	506574.68	57.88	Zheleznodorozhnik	57	340
8	6601767.60	510523.80	81.57	Unnamed wreck 8	81	4 800
9	6598283.12	502623.24	81.96	Unnamed wreck 128	81	3 500
10	6598040.72	502320.00	87.02	Villy?	87	3 996
11	6609680.44	510312.12	76	Izhe 152	1 208	5 210
12	6609581.09	505193.18	-	Possible wreck Marked on sea chart F-20- unconfirmed	-	170

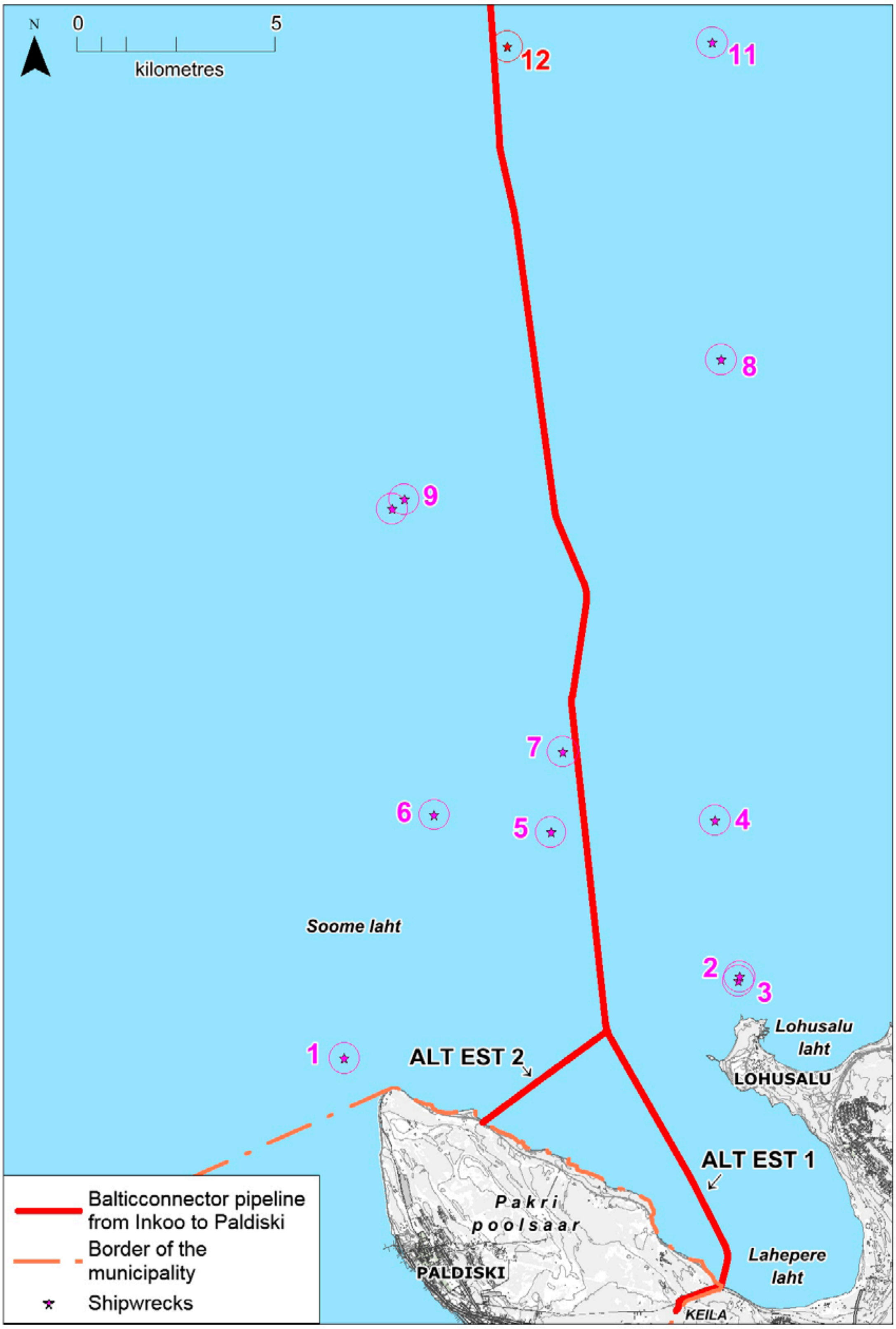


Figure 5-42. Shipwrecks which are located in the project area (within 5 km of the route of the Balticconnector natural gas pipeline). Possible shipwrecks are marked in red (No 12, Marked on sea chart F-20) – (Table 5-18).

One previously known shipwreck (number 7 in Table 5-18 and Figure 5-42) is located within two cable lengths of the route of the natural gas pipeline – the Balticconnector natural gas pipeline will be constructed inside the potential protection zone of one of the known shipwrecks the Zheleznodorozhnik.

The closest known shipwreck, Zheleznodorozhnik (number 7 in Table 5-18 and Figure 5-42, number 57 in the HIS system), is located approximately 340 m from the planned route of the natural gas pipeline. The National Heritage Board has started the process to place the tanker Zheleznodorozhnik under protection. Zheleznodorozhnik (Tamara before 1917) was built in Germany in 1898. The tanker was sunk by a mine on July 21, 1941. The wreck lies at the bottom of the sea, on an even keel, at a depth of 57.8 m according to data from the Estonian Maritime Administration and at a depth of 65 m according to data from the National Heritage Board.

The next closest known shipwreck to the proposed route of the Balticconnector natural gas pipeline (number 5 in Table 5-18 and Figure 5-42, number 178 in the register of the National Heritage Board and number 52 in the HIS system) is an unnamed vessel at an approximate depth of 52 m, approximately 850 m from the planned Balticconnector gas pipeline.

One possible wreck, which is marked on sea chart F20, but not confirmed, is located approximately 170 m from the planned route of the natural gas pipeline (number 12 in Table 5-18 and Figure 5-42).

5.1.18 Nature reserves

The first small nature reserves were established in Estonia in the 1910s and 1920s. Located on the northern coast of Estonia, the Lahemaa National Park was established in 1971.

Most of the nature reserves in the archipelago areas of the Gulf of Finland on the Finnish side were established in the 1920s and 1930s. In the 1980s, three national parks were established in coastal areas: Eastern Gulf of Finland National Park in 1982, Archipelago National Park in 1983 and Ekenäs Archipelago National Park in 1989. The international and national objective has been to establish an ecologically coherent network of nature reserves in coastal and marine areas (*Finnish Environment Institute 2014*).

The coastal and marine areas of significance to archipelago nature, bird fauna and natural underwater environment are included in the Natura network in both countries. In some of the Natura sites, protection has been implemented through the establishment of nature reserves, but natural values can also be protected through other means.

A key role for the protection of the Baltic Sea is cooperation between the coastal states (*Finnish Environment Institute 2014*). Finland and Estonia are also parties to several international agreements concerning the Baltic Sea. An agreement that is of international significance is the Convention on the Protection of the Marine Environment of the Baltic Sea (the Helsinki Convention), which, following a revision, entered into force in 2000 (*RT II 1995, 11, 57*). Implementation of the Convention is governed by the Baltic Marine Environment Protection Commission (HELCOM), where the Baltic rim states cooperate with the European Commission. In 2009, the EU adopted the Strategy for the Baltic Region, and the implementation of its environmental aspects is sought under the Baltic Sea Action Plan adopted by HELCOM. The most significant marine and coastal areas from the conservation perspective are included in the HELCOM Marine Protected Areas (MPAs) (formerly Baltic Sea Protected Areas, BSPAs). Some HELCOM MPAs are also located in Russian territory in the eastern part of the Gulf of Finland.

The Pakri Birds Directive site is included in the Natura 2000 network for the protection of 18 bird species and their habitats and the Pakri Habitats Directive site, also included in the Natura 2000 network for the protection of five species and their habitats as well as 22 habitat types (see chapter 6.7.2).

5.2 Current state in Pakri area

5.2.1 Coast and shore processes of Lahepere Bay

The so-called cliff bay of Lahepere lies in the area between the peninsulas of Pakri and Laulasmaa, running from the northwest to the southeast. The width of the water area of the bay from west to east, from Cape Nabe (Nabe neem) to Cape Pakri (Pakri neem), is approximately 8km; the width of the central section of the bay from northeast to southeast, from Cape Nabe to the Leetse Manor area – that is, from the rear of the bay to approximately 4 km in the middle of the bay – extends to 5 km.

From the west, Lahepere Bay is delimited by the eastern coast of a peninsula formed in Cambrian rocks (mostly sandstone and limestone) – a klint peninsula where the solid rocks are subject to intense wave action or have been subject to intense abrasion during earlier stages in the development of the Baltic Sea.

The eastern side of the bay is delimited by Lohusalu Peninsula within which mostly loose sediments (mainly moraine, gravel and sand) from the glaciers and its melt water and earlier stages of the Baltic Sea are subject to abrasion. The shoreline is approximately 22 km long, with the sandy shores at the top of Lahepere Bay accounting for 8 km.

Depending on the lithology of the earlier rocks, sediments and the specific features of the relief, storm wave action has resulted in the formation of various shore types, from typical erosion shores – cliffs and scarps – to depositional gravel and sandy shores.

Under the morphogenetic classification of coasts and shores, this entire area rates as a straightening erosion – accretion embayed coast that has formed in the Pre-Quaternary bedrock and is considered as a subtype of coast with klint bays.

This coastal subtype is generally characterized by the occurrence of erosion processes varying in intensity and erosion shores – cliffs and scarps – in the immediate vicinity of the peaks of peninsulas surrounding the bay, the longshore transport of sediments along the coast of the bay toward the end of the bay, and the final accretion of material at the top of the bay, where typically accretion shores, sandy and gravel shores, occur.

5.2.1.1 Specific features of shore processes

In accordance with the dynamic of shore sediments, the longshore drift of the sediments in the bay is dominated by movement from the sides of the bay toward the top of Lahepere Bay, proven by the mouths of streams draining into the sea on the sides of the bay (for instance, Klooga oja), which has turned toward the top of the bay as a result of sand transport from the north. Active longshore movement of the sediments in the same direction is also indicated by the extensive sandy shore formed by accretion on the southwest side of the stone mole built at Klooga in the 1970s.

At the same time, the shore on the northeast side of the mole is becoming muddy and overgrown, since there is no longer enough sand to feed the sandy shore on the other side of mole.

Treppoja, which drains into the top of the bay, is situated virtually in the area of the final accretion of sand and its mouth, in the area of the break through to the sea, has turned slightly north. This indicates either a final or a changing direction of longshore transport of sand.

During the geological development of Lahepere Bay, due to the intensive movement of sand from the eastern coast of the bay toward the top of the bay and its accretion there in recent millennia, the mouth of Treppoja has increasingly turned toward the south and now runs more than ½ km parallel to the shoreline behind the foredunes.

The orthophoto of Lahepere Bay clearly shows the curtain-like position of underwater sand bars on either side of the bay, their position pointing to the movement of sand and final accretion at the top of Lahepere Bay.

Transport of sediments from the sides of the bay toward the top of the bay is also indicated by the so-called "stones with parachutes" making their way onto the accretional, Klooga-Rand sandy beach at the top of the bay. Studies, including underwater work by divers, have proven that there are no signs of erosion, no cobbles or boulders in the immediate vicinity of the sandy shore on the shore and also on the nearshore seabed.

However, such areas of erosion, mainly of moraine, do feature on the eastern coast of the bay at a distance of 3–4 km, where typically a boulder-rich till shore occurs. From this area, cobbles with bladderwrack attached on them, which gives them additional buoyancy, have likely drifted during strong storm events to the area of sand accumulation at the top of the bay and, from there, have been tossed onto the shore.

5.2.1.2 Specific features of the formation of the sandy shores at the top of Lahepere Bay

For a large part of the shore of Lahepere Bay – particularly at its top section from the village of Kersalu on the southwest coast of the bay to the center of Laulasmaa Peninsula, up to about Heliküla – the distribution of shore types is pre-determined by sediments in the buried ancient valley and by the morphology of its slopes. According to data from geological and well drilling, the depth of this ancient valley of Klooga is approximately 40 m at the bottom of the bay, with the valley continuing from the northwest to southeast also on the seabed of Lahepere Bay. Typically, such buried ancient valleys are filled with fine-grained loose sediments: sand or gravel. As a result, wide, sandy shores dominate where the present-day shoreline 'intersects' with the buried valley. The sand on the sandy shores originates from the sediments of that ancient valley. The main process has been a selective washing-through of loose sediments by storm waves. As a result of the action of storm waves and winds, well-formed foredune ridges occur along the landward boundary of the active sandy shore of such bays.

Such a wide, sandy shores forming within the ancient buried valleys at the top sections of the bay between the small klint capes occur also in several places elsewhere to the east of the survey area. The best known of these include the sandy shore at Vääna at the aperture of the approximately 130-m deep ancient valley at Vääna, the sandy bathing area at Kakumäe, within the approximately 100-m deep ancient valley at Harku, and the sandy bathing area at Pirita. within the approximately 130-m deep ancient valley at Mähe. Typically, most of the sand of these sandy shores originates from the sediments of those ancient valleys. The material eroded from the abrasion bluffs nearby, plays a minor role in the total sediment budget of such beaches.

On the eastern coast of Lahepere Bay, from the proximity of the Heliküla area, the accumulative sandy shore gradually becomes an erosional till shore terminating on Cape Nabe (Nabe Neem). This area is characterized by the extensive amount of boulders on the shore, and by an indented shoreline whose small capes have been formed by abrasion of moraine rich in boulders. In the gently sloping inlets between the small capes, fragments of accumulative gravel shores may exist. The material of these shores originates from the capes.

A transitional zone where the sandy shore becomes a till shore, abrasion bluffs in the backshore and dune sand may occur. This material is subject to intense abrasion during high sea level events and extreme storms, such as the January 2005 storm. It should be noted that under the conditions resulting from that extraordinary storm, where sea levels were over 1 m higher than average, the shores in the bay were subject to intense abrasion almost along their entire length. At the top of the bay, for instance, already stable foredunes were destroyed or flattened. Within the wide sandy shore on the southwest side of the Klooga stone mole, foredunes were completely destroyed. For example, one survey pole installed inside such a dune was exposed along to length of ~80 cm, being thus rendered unusable.

5.2.1.3 General description of the shores on the western coast of Lahepere Bay

Based on geological properties, the western coast of Lahepere Bay is different to the eastern coast. On the western coast, the main morphological feature is the Baltic Klint, starting from the small cape at Pakri and continuing toward the northwest, along a shore segment of approximately 8 km. Based on its geological properties, the segment has been divided into two: Leetse Cliff, a direct continuation of Pakri Cliff, and Lahepere Cliff, its southern section to the southeast of Leetse Manor.

Now, only the classical limestone cliffs, which occur as an approximately 600–700-m long section of the shore to the southeast of Cape Pakri, are subject to active abrasion during storms. Here, the bluff is 15–20 m-high. The material formed as a result of abrasion of the bluff – predominantly consisting of gravel and pebbles of carbonate rock – moves towards the southeast. The long-term accretion of this material has resulted in the formation, at the foot of the klint, of wide, approximately 1.5-km long gravel beaches. A group of gravel-pebble ridges has formed a small cape along the southeast boundary of the accumulative shore segment. The accumulative cape extends from the foot of the klint toward the sea to a distance of several hundred meters. The accumulative cape described has been selected as the site for the LNG terminal on the Estonian side. The southeast boundary of this active accretion shore is a vestigial small cape strewn with boulders stretching far out to sea, which prevents gravel and pebbles from migrating further toward the southeast.

The landfall of the proposed gas pipeline route, ALT EST 2, is located on the boundary between this shore segment and the erosion-accretion shore that follows it. The shore here is narrow, and the talus that has formed at the foot of the klint at this pointshows clear traces of abrasion. Over an extensive area, up to 200-m wide, the nearshore sea is shallow and gently sloping, with large numbers of erratic boulders. (Figure 5–43). This is likely to be the abrasion platform of a cliff that has retreated due to storm action over the centuries. On the land side, the bluff has two scarps. The lower bluff is predominantly sandstone and is approximately 4–5-m high. The higher bluff has been formed predominantly in carbonate rock (Figure 5–44), its edge rises 15–20 m above sea level.

Figure 5–43. Illustrative photo of the area of ALT EST 2, in Pakrineeme landfall. Over an extensive area of up to 200 m wide, the nearshore sea is shallow, with large numbers of erratic boulders.

Figure 5–44. Illustrative photo of the area of ALT EST 2, in Pakrineeme landfall. Whereas the foot of the lower bluff is predominantly sandstone and approximately 4-5-m high, the higher bluff has been formed predominantly in carbonate rock and its edge rises 15–20 m above sea level.

The coast onwards from the accrumulative cape is variable for approximately 4 km towards the southeast. The bluff of the klint is further inland, and the present-day shore has a mostly indented shoreline. Boulder-strewn small capes subject to abrasion and gently sloping nearshore, predominantly small sandy inlets and sandy shore segments are typical here.

In places, the sections of sandy shore are relatively wide. For instance, in the Leetse Manor area, where they have been turned into campsites by the State Forest Management Centre (RMK).

In several places in this area of small capes, there are signs of the retreat of the cliff: remnants of the abrasion platform. Here, these include the pyrite layer (Kallavere

Formation), which is particularly resistant to the erosive action of storm waves.

After the sandy shore approximately 1.5 km to the southeast of the Leetse Saunakivi boulder, there occurs an active approximately 600-m-long sea cliff – Leetse Cliff, whose bluff rises over 10 m in height. Today, this is an active section of the Lahepere Klint. There are three small and relatively water-poor waterfalls cascading down the geologically passive southern bluff: Valli, Põllküla and Kersalu.

In the southeastern / southern direction, a partly overgrown talus extends over the bluff slope, for instance, in the Kersalu area (Kersalu monitoring area). This region is subject to abrasion in places today.

This area also includes the location of the landfall of the proposed gas pipeline route, ALT EST 1. In this area, the shore shows signs of temporary abrasion. There are also occurences of accumulative gravel-pebble and sandy beach fragments. One such small accumulative body of sediment, indicating a modest north to south transport of shore sediments, has formed on the north side of the rock reef (Figure 5–45), which may also be a small mole constructed by local residents for dragging boats on the shore (former farmer's landing). The nearshore sea is gently sloping, with 2 to 3 sandbanks.

Landward, the shore in the landfall area is a bluff that has overgrown. Its graduation can still be observed in places,. The height of the edge of the bluff is buried under a talus and reaches rises to a height of approximately 10 m (Figure 5–45 and Figure 5–46). From this area toward the bottom section of the bay, an area of transition from erosion shore to accretion shore begins, as can be seen on the shore to the south of Liivaotsa Village.

Figure 5–45. Illustrative photo of the area of ALT EST 1, in Kersalu. In places (behind the ridge of boulders blocking the movement of sediments), fragments of gravel and sandy beaches also occur. Here, the nearshore sea is gently sloping, with 2 to 3 sandbars.

Figure 5–46. Illustrative photo of the area of ALT EST 1, in Kersalu. Landward, the shore and talus in the landfall area is vegetated.

5.2.2 Geology

At the Kersalu landfall (ALT EST 1), the 9-m-high North Estonian Klint is completely covered by talus, rising relatively gently from a narrow shore.

The buried Klint has the following structure from top to bottom: up to 1 m, Quaternary sediments (drift-line limestone shingle and weathering product); up to 7 m, limestones in the Middle Ordovician Kõrgessaare, Väo, Kandle, Pakri and Toila Formations (strong crag rock, crush resistance 100–150 MPa); approximately 2-m glauconite sandstone in the Lower Ordovician Leetse Formation (*Suuroja 2010b*). The rising klint scarp at the landfall is flattened and partly covered by rubble. Glauconite sandstone is exposed under approx. 1 m of rubble at the foot of the scarp. The bottom slope (height-width ratio 1:2,5) is between 1.50 to 7.50 m (absolute height) from the foot to the ledge, and the upper slope (height-width ratio 1:7), between 7.50 to 9.00, begins after a strip of level ground approximately 10-m wide. Further on from that point is level ground with a dirt road at a height of 10 m and the gravel Vana-Tallinna maantee road at 10.5 m. The limestone plateau under whose thin (up to 1 metre) top soil limestones of the Middle Ordovician Uhaku and Lasnamäe deposits are exposed, the area along the edge of the klint scarp rises from a height of 9–10 m to 15 m above sea level in the middle of the peninsula, in the vicinity of the proposed compressor station, along Tallinn Highway. The thickness of the thin (mostly < 1 m) top soil covering the limestone plateau and consisting mostly of limestone shingle increases in the vicinity of the route landfall to 2–3 m at the expense of drift lines and the swamps (peat layer) behind these.

At the Pakrineeme landfall (ALT EST 2), the North Estonian Klint is up to 23 m high. It consists of two scarps, the lower scarp is approximately 5-m high, is partly covered by talus and formed in alum shale and sandstone. The higher scarp rises sharply upward approximately 17 m from a narrow terrace. On the scarp and at its foot, from top to bottom there are exposed: (1) up to 2 m, Quaternary sediments (mostly drift-line limestone shingle); (2) up to 7 m, limestones in the Middle Ordovician Kõrgessaare, Väo, Kandle, Pakri and Toila Formations (strong crag rock, crush resistance 100–150 MPa); (3) approximately 2 m, glauconite sandstone in the Lower Ordovician Leetse Formation (very weak to weak rock, crush resistance 1–20 MPa); (4) up to 5 m alum shale or graptolite argillite in the Lower Ordovician Türisalu Formation (averagely strong rock, crush resistance 40–50 MPa); (5) up to 25-m thick deposits, Lower Cambrian Formation and Lower Ordovician sandstone (very weak to averagely strong crag rock, crush resistance 1– 40 MPa) (*Suuroja 2010b*).

A limestone plateau covered with a thin (mostly <1 m) layer of shingle, onto which limestones in the Middle Ordovician deposits of Haljala, Uhaku and Lasnamäe open, rises to approximately 30 m above sea level in the middle of the peninsula, to the northeast of the City of Paldiski, in the vicinity of Neosti. Then, the limestone plateau descends toward the northwest to approximately 10 m above sea level between Kersalu and Laoküla.

5.2.3 Hydrogeology

Both landfall areas, Kersalu and Pakrineeme, fall directly within the drainage area of the aquifer represented by Ordovician carbonate rock. There is direct discharge off the Ordovician / Cambrian scarp of the Baltic Klint. The Ordovician aquifer is made up of silty clays in the Varangu Formation, alum shale in the Türisalu Formation (Dictyonema or graptolite argillite) and, traditionally, also glauconite limestone in the Toila Formation. Within thearea, the Türisalu Formation, 4–5-m thick, has the best water-bearing properties. Permeability of the aquifer is sharply anisotropic. Whereas the lateral (sideways) filtration coefficient may vary 0.001–1.0 m/d, the transversal coefficient is mostly of the order of 10^{-6} –10^{-5} m/d or even 10^{-7} m/d. The ceiling of the Ordovician aquifer reaches approximately 15 m above sea level in the Pakrineeme landfall area, and approximately 2 m above sea level in the Kersalu area. In either area under consideration, the specific debits of the Ordovician aquifer are mostly below 0.1 l/s (*Suuroja 2010*). The carbonate complex has fresh groundwater, HCO_3-Ca-Mg-type, mineral TOC (dried residue) mostly 0.2–0.5 g/l.

5.2.4 Surface water

The catchment area of Lahepere Bay lies in the Harju sub-river basin of the Western Estonia river basin. The catchment area for surface water (including Pakri Peninsula) is managed under the water management plan for the Western Estonia river basin, approved under Estonian Government Directive No 118 of April 1, 2010, "Approval of the water management plan" *(Lääne-Eesti 2010)*. The water management plans prepared for the Eastern Estonia, Western Estonia and the Koiva River basins were prepared for the 2009–2015 period. On January 6, 2012, the Ministry of the Environment initiated the preparation of new water management plans to be introduced for 2015–2021 *(Lääne-Eesti 2014)*. For this, the water management plan prepared in 2010 for the Eastern Estonia, Western Estonia and Koiva River basins will be updated. Along with a water management plan, an action programme under the water management plan and a plan to mitigate risks related to a flooding hazard will be made. The draft 2015–2021 water management plan is publicly available from December 22, 2014 *(Lääne-Eesti 2014)* and final version will be available by December 22, 2015.

In the water management plan, the coastal waters are classified by salinity specific hydromorphological characteristics. The coastal waters of Pakri Bay (code EE_6), including Lahepere Bay, are Type III, as mesohaline (water with a salinity of 5– 18 o/oo) and deep coastal waters (western section of the Gulf of Finland).

The ecological condition of the coastal waters in Pakri Bay is poor, whereas their chemical condition is good. The pressure factor affecting their poor condition is transport – vessel traffic, and no improvement in condition had occurred by 2015. The objective is to achieve good condition in 2021 (*Lääne-Eesti 2014*).

A major watercourse draining into Lahepere Bay is Treppoja (VEE1098900) (Figure 5-47). river runs through the villages of Illurma, Tõmmiku, Valkse, Keelva, Kloogaranna and Tuulna in Keila Rural Municipality and the town of Keila, Harju County. Treppoja, including its tributaries, is 12.7-km long, with a basin of 45.1 km². Tuulna oja drains into Treppoja on the left bank, 0.5 km before the mouth at the sea (VEE1099000). Tuulna oja flows through Klooga Town, Kloogaranna village and Tuulna village. Tuulna oja is 9.1-km long, including its tributaries, and has a basin of 26.5 km². Under the Water Framework Directive (WFD: 2000/60/EU), the typology of Treppoja and Tuulna oja is IB: rivers with light-colored water and low concentrations of organic matter, and basins measuring 10–100 km². Treppoja is a publicly used waterway with a 100-m wide restriction zone along its banks under Estonian Government Regulation of July 18, 1996, No 191 Approval of the list of publicly used bodies of water (*RT I 1996, 58, 1090 ; EELIS 2014*).

The ecological condition of Treppoja (including Tuulna oja) is good in terms of being a natural body of water and in terms of large invertebrates. Also, the chemical condition is good, determined by analogy and pressure factors based on expert opinions, since there are no data on individual quality elements *(Lääne-Eesti 2010)*. The ecological condition until 2013 has not changed (*Lääne-Eesti 2014*). Flow control and pattern modification are forbidden on Treppoja oja, which is a river where salmonids spawn (*Regulation of the Ministry of the Environment No 73 of June 15, 2004*) (*RTL 2004, 87, 1362*).

Approximately 0.5 km to the west of the mouth of Treppoja, Klooga (Lahepere) oja (Figure 5-47) drains into Lahepere Bay (VEE1099100). The stream flows through Kloogaranna Village, Klooga Town, Keila Parish Rural Municipality in Harju County. Klooga oja, including its tributaries, is 2.8 km long, and has a basin of 3 km² Under WFD: (2000/60/EU), the typology of the stream is IB. It is not a public or publicly used body of water. There is a 50-m wide restriction zone along the banks of the stream under Regulation of the Ministry of the Environment No 99 of 6 December 1999, "List of bodies of water or parts thereof used as recipients for wastewater based on their sensitivity to pollution" (*EELIS 2014*).

On the line segment between Kersalu and Leetse Cliffs, there is the geologically passive bluff of Lahepere Klint, with three small waterfalls descending from it: Valli, Põllküla and Kersalu (Figure 5-48). The waterfalls are recipients for drainage ditches and run dry when there is little water. The southern branch ditch of Kersalu Waterfall runs through the Tallinn Highway embankment in a culvert. Approximately 40 m downstream from the culvert, the ditch intersects with the proposed Balticconnector natural gas pipeline.

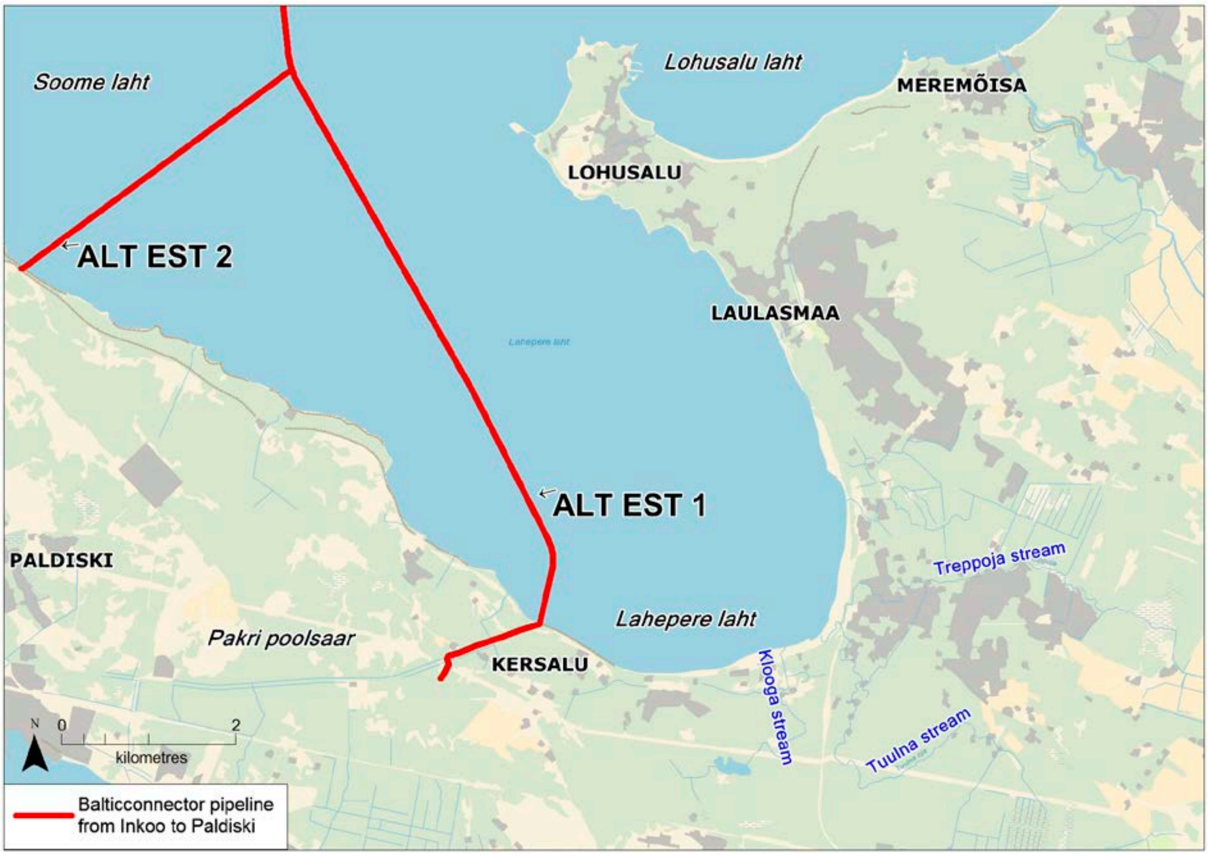


Figure 5-47. Streams draining into Lahepere Bay.

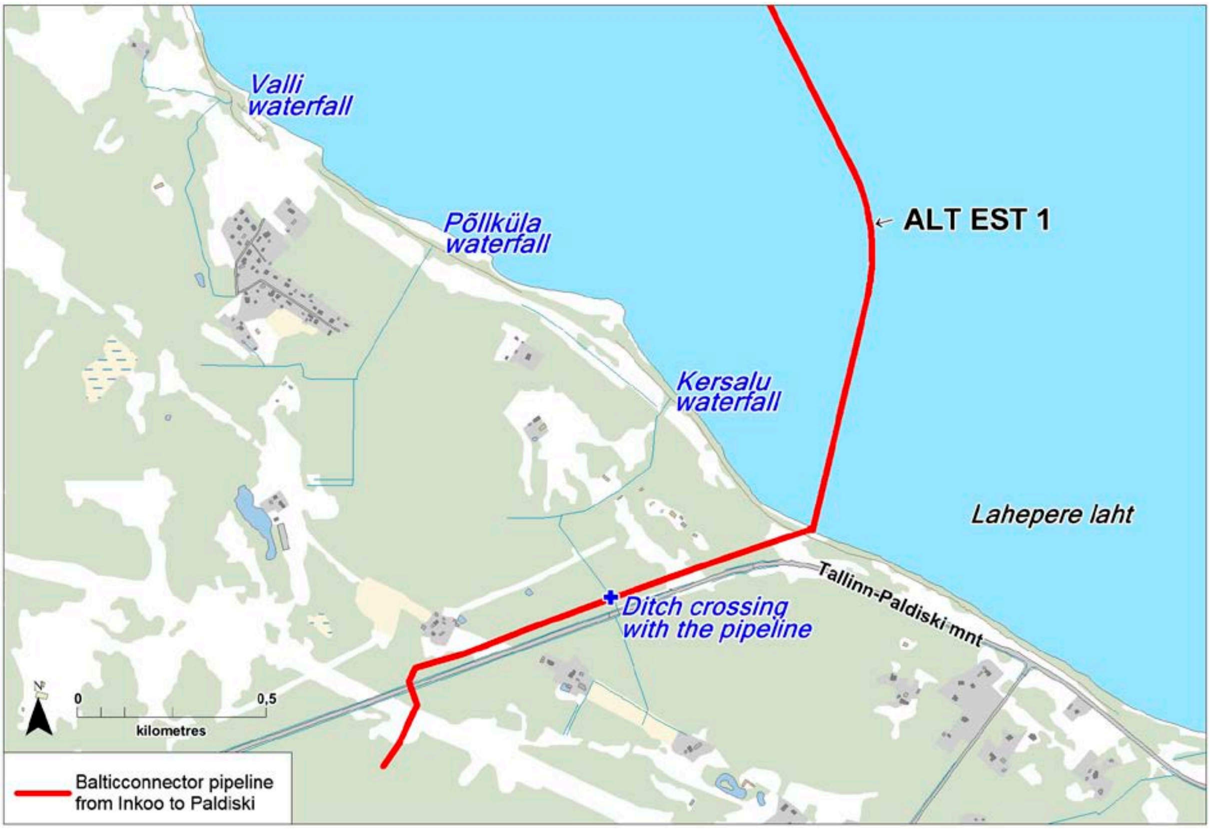


Figure 5-48. Waterfalls of the drainage ditches from Kersalu to Leetse.

5.2.5 Air quality

Emissions in Paldiski

The most significant sources of emissions in the City of Paldiski are presented on the basis of the environmental permits for outdoor air granted (Fortum Eesti AS Biodiesel, Paldiski AS boiler plant and Soojusenergia OÜ boiler plant).

The maximum permitted emissions into the air on the basis of the permit decisions are shown in Table 5-19.

Table 5-19. Maximum annual emissions into the air in Paldiski on the basis of environmental permits issued (*Estonian Environment Information Centre, information system of environmental permits*).

	Nitrogen oxides	Particulate matter	Sulfur dioxide	* Carbon monoxide	VOCs
	t/a	t/a	t/a	t/a	t/a
Energy production	83.9	54.3	117.0	198.5	14.0
Other	9.3	24.9	23.1	16.1	2.2
Total	93.2	79.2	140.1	214.6	16.2

Air quality in Paldiski

The closest air quality monitoring equipment to the Balticconnector project area, the self-monitoring system of the Alexela company for the measurement of hydrocarbons, hydrogen sulfide and meteorological data, is located in Paldiski South Harbor. Data from the Paldiski measurement station can be viewed in real time on the Estonian Environmental Research Centre website: www.klab.ee/seire/airviro/paldiski.html.

There are no permanent monitoring points in Paldiski or on the Pakri Peninsula. No continuous air quality measurement takes place in the City of Paldiski (excluding the self-monitoring carried out by Alexela). The nearest official monitoring station is located in Tallinn, around 40 km to the east of the area.

In 2012 (August 21–28, 2012), the Estonian Environmental Research Centre conducted measurements by random sampling in Paldiski using the Mobair mobile air laboratory. The hourly mean for NO_2 was 18.3 µg/

m³, the maximum hourly mean for SO_2 was 1.57 µg/m³, the maximum hourly mean for $PM_{2.5}$ during the measurement period was 11.7 µg/m³, and the mean for the entire measurement period was 4.4 µg/m³ (*Estonian Environmental Research Centre 2013*). These findings indicate that the means measurements are clearly below the limits set by the Ministry of the Environment under decree No 43 of July 8, 2011.

Road traffic emissions from engine exhausts, such as heavy metals (led, cadmium, zinc, copper), polycyclic aromatic hydrocarbons (PAH), nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2), fine particulate matter (PM), road dust and road salt occur in the vicinity of roads. Some of the emissions (impurities) evaporate into the air, while others fall onto the road and adjacent areas.

The natural gas pipeline will run in the vicinity of the Tallinn–Paldiski National road between the KP 41 and 42 to the north and west through a landscape sheltered from the wind (by trees). The estimated traffic volume of the Tallinn–Paldiski National road at Kersalu is 2 670 vehicles per day (*Road Administration letter, August 29, 2014*). The level of air emissions on the road is relatively low due to the relatively low traffic density (< 10 000 vehicles/day, favorable winds and topography).

5.2.6 Noise

Environmental noise emitted by traffic, industry, service enterprises, sports events, etc. is sound with a pressure, which causes physical as well as psychological disturbance for people.

Regulation No 42 titled "Normative levels of noise in housing and recreation areas, residential and communal buildings, and noise measurement methods" issued on March 4, 2002 by the Minister of Social Affairs (*RTL 2002, 38, 511*) establishes the normative levels of noise in housing and recreation areas, in residential and communal buildings and outside these buildings as well as noise measurement methods.

The mainland section of the planned gas pipeline on the Pakri Peninsula in the Municipality of Paldiski is a low density area, although there are two registered immovables located approx 6090 m from the western part of the pipeline – Tallinna mnt 51 and Tallinna mnt 56 / Korka, which also includes a residential building.

Transportation noise from National road 8, Tallinn Paldiski reaches these registered immovables and can reach a remarkable level as background noise when lorries drive from and to ro-ro ships at Paldiski harbo. The level and variations of transportation noise on this national road are unidentified-unknown. The Estonian Road Administration commented on the level of noise, stating that noise has not been studied on Tallinn Paldiski road section 40.3345.67 km because the volume of traffic on that stretch is below the limit established in Directive 49/2002/EC. In 2013, the annual average traffic volume per day was 2 760, i.e. 365*2760= 1 007 400 vehicles per year. If the speed of lorries on this section in the city is >60 km/h, then the prevailing portion of transportation noise is made up of the noise of friction between the wheels and the road surface. Deriving from the strategic noise map of Tallinn and assuming that transportation noise at the Raudalu settlement on Viljandi highway with a similar traffic volume can be compared to this section within the Muncipality of Paldiski, the noise at the aforementioned registered immovables would be 6065 dBA. This is the limit of traffic noise during the day established in the aforementioned regulation. However, the background noise caused by traffic can be increased by low-frequency (< 150 Hz) and infrasound (< 20 Hz) originating from Pakri wind farm (approx 4 400 m north) as a result of northern and northwestern winds.

5.2.7 Vibrations

There is currently no activity taking place in the Kersalu or Pakrineeme landfall areas of Paldiski causing vibration impacts in the environment.

5.2.8 Natural environment

Pakri Peninsula (previously Leetse Peninsula) lies between the Lahepere Bay and Paldiski Bay on the northern coast of Estonia. Its outcrop is 12 km in length and over 5 km in width, with a surface area of approximately 40 km² and a height up to 31 m. The most common habitats on the peninsula are alvars, wooded meadows and broadleaf forests. Nature has been largely influenced by the calcareous and thinly layered soils and strong maritime climate. On the one hand, this is the reason for calcareous plants and the animals feeding on them, and on the other hand also brings about the existence of plants resistant to humidity, winds and salt and the animals feeding on such plants. The limestone cliff lining the peninsula and the lower sandstone cliff on its eastern side are also of importance, since they form an abundant habitat with a microclimate of its own. The plateau on the cliff is covered with alvars, which have largely degraded due to human activity (or lack of it). A distinctive characteristic on the Pakri Peninsula, are secondary biotopes in abandoned limestone quarries, gravel pits and several military structures.

To better understand the current biotic environment on the Pakri Peninsula, it is first necessary to examine the history of the area and its existing natural conditions. The development of natural habitats has been influenced by two very important factors – the occurrence of limestone so close to the surface, and considerable human activity through history (i.e. the once popular tourism and extensive farming area suddenly became a closed military area during the Soviet era). Additionally, a third condition is brought about by the geographical location on the coast. Namely, the area lies on the migratory corridor of several insects and birds (*Klein 2014*).

The main historical difference between the Balticconnector pipeline alternative routes (ALT EST 1 near Kersalu and ALT EST 2 near Pakrineeme) is the fact that the Pakrineeme area has remained untouched by human activity, except for the historical road alongside the coastline. The road has not, however, greatly influenced the habitats; only recently has the impact increased due to motor vehicle use on the forest road). The Kersalu area has seen several changes due to human activities – the former road infrastructure has totally changed, as has the use of land, several meadow areas have been left unused.

5.2.8.1 Plants

The vegetation on the proposed alternative pipeline routes, ALT EST 1 and ALT EST 2, under the current environmental impact assessment differ greatly from each other. Whereas ALT EST 1 in Kersalu runs through several different biotopes (dry meadow, wet meadow, forests) on its route parallel to the highway, the construction zone in ALT EST 2 in Pakrineeme only covers thin strips of forest biotopes. The two alternatives differ also in surface area – ALT EST 1 with its 32-m wide route corridor covers approximately 3 ha; ALT EST 2 with its construction zone (at the foot of the bluff) up to only approx. 0.1 ha. This disparity in surface area must be factored into the report on vegetation (and other species groups below).

Since the vegetation on the alternative route areas has never been mapped, mapping was conducted within the framework of this environmental impact assessment between May 2014 and July 2014 (*Klein 2014*). Fieldwork aspects of the vegetation were recorded for both alternative route areas monthly, mapping most important findings and also more interesting or significant species in terms of habitats.

According to the environmental register, the ALT EST 1 route in the Kersalu area and its close vicinity are not home to any protected plant species. Additionally, there are no known new sites of category I protected plant species. As regards protection categories, at least 50% of the known sites of category II and 10% of category III protected species must be protected by a nature reserve, special conservation area or species protection site ((*RT I 2004, 38, 258*). The following category II and III protected plant species new sites were recorded in the area (Figure 5–49):

1. **Fumewort** (Corydalis intermedia), category II protected plant species. The site where this species is found growing alongside the solid-rooted fumewort (*Corydalis solida*) lies about 100 m to the east and north-west of the pipeline landfall point in the ALT EST 1 alternative. When measured diagonally from the route, it lies to the north-west and north about 50 m of the centre line of the pipeline route, on the seaward side of the historic road on the cliff (Figure 5–49). The size of the site is approximately 200 m². According to the environmental register, there are only 24 known sites of this species in Estonia – two are in Harju County: one in Viimsi and the other two are in Nissi rural municipalities (plus one in Võru, Tartu and Järva counties, with all the rest being in Saaremaa). Therefore, this is a very important site for this species, constituting 4% of the entire number of sites in Estonia and one third of the sites in Harju County. Of these 24 sites, 14 (58%) are located in protected areasas provided in the environmental register. One site in Harju County, where *Corydalis intermedia* grows, lies within a reserve, the other does not. Thus, 50% of sites are protected, although the overall number of sites in Harju County is very small.
2. **Small pasque flower** (Pulsatilla pratensis), category III protected plant species. There are two sites very close to each other that are located 7080 m toward the peninsula down the center axis of the pipeline landfall point in the ALT EST 1 alternative and on both sides of it (Figure 5–49). The sizes of the sites are approximately 20 and 30 m², with 30 and 40 blooming plants in each respectively. According to the environmental register, there are 309 known sites for this plant in Estonia. Of these sites, 63 are in Harju County, where two of them are in the precinct of Paldiski (one approx. 600 m² with 100 plants in the southern side of Suur-Pakri Island, and the other, approximately 1 000 m², with 300 plants on the Pakri (Kalaranna) Peninsula). Therefore the new sites make up ca. 0.6% of the total number of sites in Estonia; 3% of sites in Harju County, and one third of the sites in the administrative territory of the City of Paldiski (3% in surface area and 15% by number of plants). However, only one of the sites within the precinct of Paldiski lies in a landscape protection area. The others (incl. this new one) are outside protected borders. According to the environmental register, 280 of the 309 (90%) sites in Estonia are protected; the numbers in Harju county are 57 and 90% respectively.
3. **Tall thrift** (Armeria maritima subsp. elongata), category III protected plant species. There are two sites located within the perimeters of ALT EST 1, the smallest site lies 75 m inland and approximately 8 m south of the center axis of the pipeline; the other encompasses the entire pipeline perimeter area on a stretch of about 100 m, starting 300 m inland from the landfall point (Figure 5–49). The smaller site is 30 m², and the larger one is approximately 9 000 m². The number of blooming plants is 30 and > 2 000 respectively. According to the environmental register, there are only 22 known sites of this species in Estonia, 21 sites are located in Harju County (one is in Lääne Viru County). However, neither the City of Paldiski nor the western side of Harju County have

any known tall thrift sites. Therefore, the newly found sites constitute approx. 8% of the sites in Estonia and 9% of the known sites in Harju County that are recorded in the environmental register. Nevertheless, it must be noted that there unlikely to be any other site in Estonia that is larger and richer in plant numbers than the new Kersalu site of discovery. According to the environmental register, 14 of the 22 (60%) sites in Estonia are protected; the numbers in Harju County are 13 and 60% respectively.

4. **Common twayblade** (Listera ovata), category III protected plant species. There are two sites within the ALT EST 1 pipeline corridor, the smaller site is located 1 km the inland, 15 m to the south of the center axis of the pipeline, and the other, larger site is spread across the entire pipeline corridor width at the end of the route, just before the compressor station (Figure 5–49). The smaller site is a small spot with only two blooming plants. However, the larger site covers almost 4,000 m², with the number of blooming flowers at 200. There are 1,596 known sites of the species in Estonia, 177 of which are in Harju County, and 11 in the area of the City of Paldiski. Therefore, the new locations constitute only 0.% of the known number of sites of the species in Estonia; 1% in Harju County and 15% in the administrative territory of the City of Paldiski. All the sites that are partially or fully located in the landscape protection area remain in limited management zones. According to the environmental register, 894 of the 1,596 (56%) sites in Estonia are protected; the numbers in Harju County are 106 and 60% and in the administrative territory of the City of Paldiski: 2 and 18% respectively.
5. **Military orchid** (Orhis militaris), category III protected plant species. There is one site within the perimeters of the ALT EST 1 pipeline route, and this is located at the end of the route, just before the compressor station (Figure 5–49). The site measures approx 600 m², with the number of blooming flowers at 30. According to the environmental register, there are 728 military orchid sites in Estonia: 53 are located in Harju County with 27 in the administrative territory of the City of Paldiski. Therefore, out of the sites recorded in the environmental register, these new locations make up approximately 0.1% of the sites in Estonia, 2% of sites in Harju County and 4% of sites in the administrative territory of the City of Paldiski. According to the environmental register, 373 of the 728 (51%) sites in Estonia are protected; the numbers in Harju County are 17 and 32% and in the administrative territory of the City of Paldiski: 10 and 37% respectively.
6. **Lesser butterfly orchid** (Platanthera bifolia), category III protected plant species. There is one site within the perimeters of the ALT EST 1 pipeline route, and this is located at the end of the route, just before the compressor station (Figure 5–49). The site measures approx 100 m², with the number of blooming flowers at only two. According to the environmental register, there are 1,473 lesser butterfly orchid sites in Estonia: 232 are located in Harju County with 13 in the administrative territory of the City of Paldiski. Therefore, of the sites recorded in the environmental

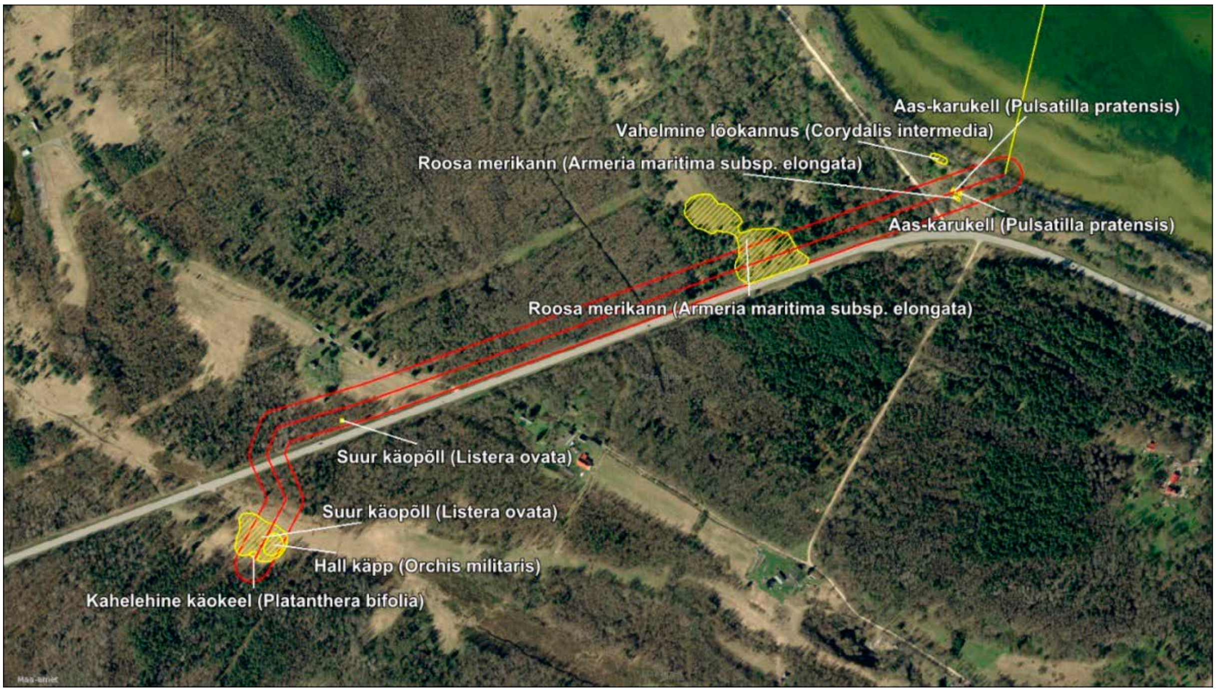


Figure 5–49. Protected vascular plant sites in the Kersalu area on ALT EST 1 pipeline route.

register, these new locations constitute less than 0.1% of the sites in Estonia, approx. 0.4% of sites in Harju County and approximately 7% of sites in the administrative territory of the City of Paldiski. According to the environmental register, 776 of the 1,473 (53%) sites in Estonia are protected; the numbers in Harju County are 147 and 63% and Paldiski town territory are 6 and 46% respectively.

According to the environmental register, there are no known sites for protected plant species in the **Pakrineeme** area nor in the close vicinity of the pipeline landfall point in the proposed ALT EST 2 route alternative. There are also no known new sites of protected plant species in the area.

5.2.8.2 Birds

The description of the current avifauna is mainly based on the Balticconnector research conducted in 2013 and 2014 (*Estonian Ornithological Society 2013*). However, the survey only focused on the Kersalu area and the ALT EST 1 pipeline route in the area. Mapping of bird nesting territories was used as a way of researching nesting birds (*Bibby 2000*).

There are 359 nesting pairs out of 39 species represented within the whole Balticconnector ALT EST 1 pipeline perimeter. Bird species represented are: *Anseriformes* (3 species), *Gruiformes* (1 species), *Charadriiformes* (5 species), *Piciformes* (1 species) and *Passeriformes* (30 species). Average population density is high – 12.0 nesting pairs per hectare. The reason for such a high population density lies in the existence of fertile marsh forest and numerous different habitat spots (coastal habitats, shrublands, coppices, small meadows) and their ecotones (*Estonian Ornithological Society 2013*).

According to the survey, the most populous species on Kersalu area is the Chaffinch (*Fringilla coelebs*) – 50 nesting pairs recorded; the Common Chiffchaff (*Phylloscopus collybita*), and the Song Thrush (*Turdus philomelos*) follow with 22 and 20 nesting pairs respectively. Therefore, the dominant species in the surveyed area are the Chaffinch, Common Chiffchaff, Song Thrush, Garden Warbler (*Sylvia borin*), Eurasian Blackcap (*Sylvia atricapilla*), and the European Robin (*Erithacus rubecula*). The Chaffinch is an eurytopic species living in different groves, but the rest of the list prefer to live in mixed and broadleaf forests. Brush areas have to be well developed for brush birds and European Robins. Areas at the perimeters of forests and with single trees are are inhabited by the Dunnock (*Prunella modularis*), Yellowhammer (*Emberiza citrinella*), Common Rosefinch (*Carpodacus erythrinus*), Lesser Whitethroat (*Sylvia curruc*, and the Icterine Warbler (*Hippolais icterina*).

There are category III protected bird species living in and around the perimeters of the ALT EST 1 pipeline alternative. At least 10% of known sites must be protected by a protected area, special conservation area or species protection site (*RT I 2004, 38, 258*).

There is only one species of protected birds living in the ALT EST 1 area (see Figure 5-50):

The Red-breasted Flycatcher (Ficedula parva), category III protected bird species, Birds Directive Annex1 species. Seven nesting pairs in ALT EST 1 area (see Figure 5-50) were found, constituting two new sites (five in one and two in the other). According to the environmental register, there are 455 sites of the species in Estonia (113 in Harju County, but none inin the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the new location constitutes approximately 0.4% of the sites in Estonia, and 2% of sites in Harju County. According to the environmental register, 360 of the 455 (79%) sites in Estonia are protected; the numbers in Harju County are 78 and 69% respectively.

The conservation status of the Red-breasted Flycatcher was good in the early 2000s, and the aim of protective status was to reduce the risk of a strong decline rate (*Lõhmus 2001*). The species is common around Estonia with an estimated population of 60,000–100,000 pairs. The population has grown strongly (>50%) both between 1980–2012 and also between 2001–2012 (*Elts 2013*). Therefore, the conservation status of the species remains favorable. The Red-breasted Flycatcher is found mainly in old, unmanaged sheltered woodlands, and in mixed forests with fir-trees, where the appropriate nesting spots can be found in old and dead standing trees (*Väli 2005*). The Red-breasted Flycatcher has also been described as favoring deciduous woodlands (*Angelstam 2004*). The high population density of the species in the Balticconnector survey area is an example of an unorthodox habitat conditions in Estonia (mainly old alder forest, where fir trees can only occasionally be found in the underwood) and the close nesting of several pairs. Rootsmäe and Veroman (1974) also noted that the species can be found closely nesting to each other in suitable biotopes, but not be present in the surrounding areas.

In addition, there are also four protected bird species recorded as inhabiting the close vicinity of the **ALT EST 1 pipeline route** (see Figure 5–51):

The Corn Crake (Crex crex), category III protected bird species, Birds Directive Annex 1 species. There are two sites close to the perimeters of the ALT EST 1 pipeline alternative– one approximately 500 m from the pipeline landfall point on the meadow between the highway and the sea towards Pakrineeme, and the other approximately 300 m from the pipeline landfall point on the meadow between the road and the sea (see Figure 5–51). According to the environmental register, there are 403 sites of the species in Estonia (123 in Harju County, but none in the in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the

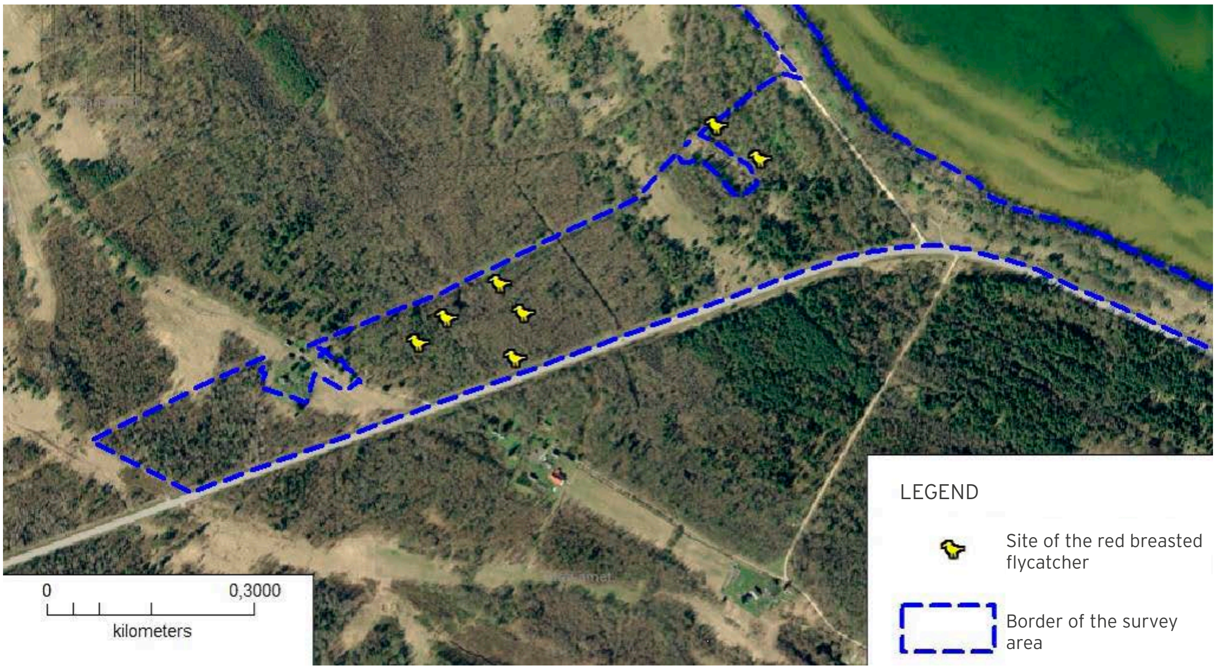


Figure 5-50. Sites of the Red-breasted Flycatcher in the area of the ALT EST 1 pipeline route *(Estonian Ornithological Society 2013).*

environmental register, the new locations constitute 0.5% of the sites in Estonia and 2% of sites in Harju County. According to the environmental register, 171 of the 403 (42%) sites in Estonia are protected; the numbers in Harju County are 20 and 16% respectively.

Red-backed Shrike (Lanius collurio), category III protected bird species, Birds Directive Annex 1 species. Close to the perimeters of the ALT EST 1 pipeline alternative(ca 600 m from the landfall point on the brushy meadow between the road and the sea towards Pakrineeme) one nesting pair (see Figure 5-51). There are 496 sites of the species in Estonia (39 in Harju County, but none in the administrative territory of the City of Paldiski) according to the environmental register. Therefore, of the sites recorded in the environmental register, the new locations constitute 0.2% of the sites in Estonia, ca. 2% of sites in Harju County. According to the environmental register, 374 of the 496 (75%) sites in Estonia are protected; the numbers in Harju County are 13 and 33% respectively.

Little Ringed Plover (Charadrius dubius), category III protected bird species. Close to the perimeters of the ALT EST 1 pipeline alternative (ca 800 m from the landfall point along the coast towards Pakrineeme) 1 nesting pair (see Figure 5-51). According to the environmental register, there are 52 sites of the species in Estonia (8 in Harju County, but none in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the new locations constitute 2% of the sites in Estonia and ca. 11% of known sites in Harju County. According to the environmental register, 27 of the 52 (52%) sites in Estonia are protected; the numbers in Harju County are 4 and 50% respectively.

Arctic Tern (Sterna paradisaea), category III protected bird species, Birds Directive Annex 1 species. In the vicinity of perimeters of the ALT EST 1 pipeline alternative, one nesting pair (see Figure 5-51). According to the environmental register, there are 287 sites of the species in Estonia (14 in Harju County and one in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the new locations constitute 0.3% of the sites in Estonia, ca 7% of known sites in Harju County and 50% of the sites found in the administrative territory of the City of Paldiski. According to the environmental register, 259 of the 287 (90%) sites in Estonia are protected; the numbers in Harju County are 13 and 93% respectively.

Common Shelduck (Tadorna tadorna), category III protected bird species. In the vicinity of the perimeters of the ALT EST 1 pipeline alternative, two nesting pairs (see Figure 5-51). According to the environmental register, there are 142 sites of the species in Estonia (three in Harju County, but none in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the new locations constitute 1% of the sites in Estonia and ca. 40% of known sites in Harju County. According to the environmental register, 137 of the 142 (97%) sites in Estonia are protected; the numbers in Harju County are 3 and 100% respectively.

Figure 5-51. Protected bird species in the vicinity of ALT EST 1 on the coastline (*Estonian Ornithological Society 2013*).

According to the environmental registry, there are no known sites of protected bird species in the Pakrineeme area nor in the close vicinity of the pipeline landfall point in the proposed ALT EST 2 route alternative. There are also no known new sites of protected bird species in the area. However, taking into account the EC Directive Habitat types in the area, it can be predicted that the following protected birds could be found in the area:

- **Red-breasted Flycatcher** (Ficedula parva), category III protected bird species, Birds Directive Annex 1 species.
- **Lesser spotted Woodpecker** (Dendrocopos minor), category III protected bird species.
- **Little Ringed Plover** (Charadrius dubius), category III protected bird species.
- **European Nightjar** (Caprimulgus europaeus), category III protected bird species, Birds Directive Annex 1 species.
- **Eurasian Wryneck** (Jynx torquilla), category III protected bird species.
- **The common shelduck** (Tadorna tadorna), category III protected bird species.

5.2.8.3 Mammals

Mammals inhabiting the Pakri Peninsula have not been notably surveyed. Findings are random and the locations recorded are ambiguous. However, 13 species of mammals have been recorded in the list of mammals inhabiting the peninsula, including one category II protected species (The brown long-eared bat *Plecotus auritus*) and two species protected under the EU Habitats Directive (the formerly named brown long-eared bat and the mountain hare, *Lepus timidus*). At least 50% of the known sites of category II protected species must be protected by a protected area, special conservation area or species protection site (*RT I 2004, 38, 258*).

Since mammals had not been specifically surveyed in the alternative pipeline route areas, a survey was conducted from May 2014 to July 2014 as a part of the current environmental impact assessment(*Klein 2014*). In the course of the field studies conducted, every significant finding in the area was recorded monthly by means of direct observation and also based on animal tracks. A separate bat detection survey was conducted to record the sites of these protected species in the area. Since considering the sites, the most likely protected mammals inhabiting the area are in fact bats, there were no other species found than bats as a result of the survey.

Eight mammal species were recorded **in the Kersalu area** and in the close vicinity of the ALT EST 1 pipeline route. Two of those species are category II protected mammals. These species are as follows:

1. **The northern bat** (Eptesicus nilssonii), category II protected mammal species. The species was found on the coast near the pipeline landfall point in the ALT EST 1 route alternative. It is the feeding area of the species, encompassing the whole half-open area between the roads and the sea, and is covered by random meadows and clusters of single trees mainly on the escarpment. According to the environmental register, there are 768 known sites of the species in Estonia (113 in Harju County, but none in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the location constitutes only 0.1% of the sites in Estonia and ca. 1% of the sites in Harju County. According to the environmental register, 473 of the 768 (62%) sites in Estonia are protected; the numbers in Harju County are 45 and 40% respectively.
2. **Nathusius's pipistrelle** (Pipistrellus nathusii), category II protected mammal species. The species was found on the coast near the pipeline landfall point of in ALT EST 1 route alternative. It is the feeding area of the species, encompassing mainly the littering and coastal sea area in front of the escarpment. According to the environmental register, there are 285 known sites of the species in Estonia (27 in Harju County, but none in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the location constitutes only 0.4% of the sites in Estonia and ca. 4% of known sites in Harju County. According to the environmental register, 203 of the 285 (71%) sites in Estonia are protected; the numbers in Harju County are 13 and 48% respectively.

In addition to the protected species mentioned above, the activity tracks of elk, roe deer, wild boar, fox, brown hare and squirrel were recorded. Big game migratory tracks were recorded separately and have been marked in Figure 5–52.

Figure 5–52. Concentration of big game migratory tracks (purple lines crossing the Balticconnector pipeline route, indicating the intersection locations) in the Kersalu area of ALT EST 1 pipeline route.

The activities of five mammal species were recorded in the area of the pipeline landfall point in the Pakrineeme ALT EST 2 route alternative: elk, wild boar, mole, water vole and northern bat. One of these is also a protected species:

The Northern Bat (Eptesicus nilssonii), category II protected mammal species. The species was found inland in the first forest on the limestone shore and the plates itself from the ALT EST 2 pipeline landfall. It is the feeding and sheltering area of the species, encompassing the whole limestone shore and the escarpment, incl. crevices and fissures in the cliffs as shelter. According to the environmental register, there are 768 known sites of the species in Estonia (113 in Harju County, but none in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the location constitutes only 0.1% of the sites in Estonia and ca. 1% of known sites in Harju County. According to the environmental register, 473 of the 768 (62%) sites in Estonia are protected; the numbers in Harju County are 45 and 40% respectively.

5.2.8.4 Amphibians and reptiles

Amphibians and reptiles have never been surveyed on the Pakri Peninsula or on the alternative pipeline routes. A survey was conducted from May 2014 to July 2014 as a part of this environmental impact assessment (*Klein 2014*). In the course of the field studies conducted, every significant finding in both pipeline areas was recorded monthly. All amphibians and reptiles are protected species. ALT EST 1 and ALT EST 2 alternative pipeline route areas are home to some category III protected species. At least 10% of the known sites of category III protected species must be protected by a protected area, special conservation area or species protection site (*RT I 2004, 38, 258*). The findings have been outlined by species below:

Moor frog (Rana arvalis), category III protected amphibian species, EU Habitats Directive Annex 1 species. Two sites were recorded on the ALT EST 1 pipeline route in the Kersalu area. Both places are located in marshy forests on the banks of a moat crossing the pipeline approximately 500600 m inland from the pipeline landfall point. However, there are more suitable habitats for the species in the area, so these locations are most likely not the only ones. Whether the species uses the moat referred to for spawning, cannot be confirmed, since the fieldwork was conducted after the spawning period(*Klein 2014*). There were no signs of the species in ALT EST 2 pipeline route area. According to the environmental register, there are 283 known sites of the species in Estonia (26 in Harju County, but none in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the location constitutes 0.7% of the sites in Estonia and ca. 8% of known sites in Harju County. According to the environmental register, 106 of the 283 (37%) sites in Estonia are protected; the numbers in Harju County are 8 and 31% respectively.

Common frog (Rana temporaria), category III protected amphibian species. Two sites were recorded on the ALT EST 1 pipeline route in the Kersalu area. The first place is located between a dry alvar and a wet mixed forest approximately 300 m from the pipeline landfall point, and is one of the richest ecotones in the area. The second location lies on a wet meadow on a high-voltage line route at the end of the pipeline route. There were no signs of the species in the ALT EST 2 pipeline route area. According to the environmental register, there are 222 known sites of the species in Estonia (35 in Harju County, but none in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the location makes up 0.9% of the sites in Estonia and ca. 6% of known sites in Harju County. According to the environmental register, 92 of the 222 (41%) sites in Estonia are protected; the numbers in Harju County are 26 and 74% respectively.

Common toad (Bufo bufo), category III protected amphibian species. One site was recorded on the ALT EST 1 pipeline route in the Kersalu area. This site is by the road on a high-voltage line route at the end of the pipeline route. There were no signs of the species in the ALT EST 2 pipeline route area. According to the environmental register, there are 204 known sites of the species in Estonia (26 in Harju County, but none in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the location constitutes almost 1% of the sites in Estonia and ca 8% of known sites in Harju County. According to the environmental register, 85 of the 204 (42%) sites in Estonia are protected; the numbers in Harju County are 16 and 62% respectively.

Common European viper (Vipera berus), category III protected reptile species. One site was recorded on the ALT EST 1 pipeline route in the Kersalu area,. This site lies next to a partially buried cairn next to a sandy meadow by a forest road, approximately 80 m inland from the pipeline landfall point. This site is located right on the pipeline route, and is directly in the pipeline construction area. The site is most likely a wintering location. One finding was made also on the ALT EST 2 alternative pipeline route. This was recorded 250 m from the pipeline landfall point on a forest road near a rocky levee providing suitable cover for the species, 250 m north-west of the pipeline landfall point. According to the environmental register, there are only 14 known sites of the species in Estonia (only one in Harju County, but none in the administrative territory of the City ofPaldiski). Therefore, of the sites recorded in the environmental register, the location constitutes 7% of the sites in Estonia and 50% of known sites in Harju County. According to the environmental register, 5 of the 14 (36%) sites in Estonia are protected; only the most recent known site in Harju County is not protected.

Viviparous lizard (Zootoca vivipara), category III protected reptile species. One site was recorded on the ALT EST 1 pipeline route in the Kersalu area,. This site lies in a marshy mixed forest 1 km inland from the pipeline landfall point, approximately 5 m south of the pipeline axis. According to the environmental register, there are only 35 known sites of the species in Estonia (12 in Harju County, but none in the area of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the location constitutes 3% of the sites in Estonia and 8% of known sites in Harju County. According to the environmental register, 13 of the 35 (37%) sites in Estonia are protected; there is only one site protected in Harju County and this constitutes only 8% of site protection.

5.2.8.5 Invertebrates

True butterflies are the most studied out of invertebrates inhabiting thePakri Peninsula. Records show there are 257 species living in the area. Of these, 130 are diurnal and 127 nocturnal species. Six are protected species. The closest habitats to the alternative pipeline routes covered in this environmental impact assessment are the Kalaranna Peninsula (a couple of hundred meters north-west along the coast from the pipeline landfall point of of the Pakrineeme alternative) and on the seaward side of the Kersalu alternative route.

The fieldwork conducted within the framework of this environmental impact assessment (*Klein 2014*) sought to specify the data on invertebrates on both alternative route areas, focusing on true butterflies, bumblebees and Formicas, since these have the largest number of protected species. The areas of the ALT EST 1 and ALT EST 2 alternative pipeline route s are ome to category III protected species. At least 10% of the known sites of category III protected species must be protected by a protected area, special conservation area or species protection site (*RT I 2004, 38, 258*). The findings have been outlined by species below:

Kersalu route (ALT EST 1):

Black and yellow chaperon (Phragmatobia luctifera), category III protected species. Found in one location on the route, on a dry alvar meadow about 300 m inland from the pipeline landfall point. The location was recorded by the finding of one specimen in a spider web in the grass. According to the environmental register, there are only eight known sites of the species in Estonia – all of these are located in Harju County, with four being in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the location constitutes 11% of the sites in Estonia and 20% of known sites in Harju County. According to the environmental register, 5 of the 8 (63%) sites in Estonia are protected.

Large copper (Lycaena dispar), category III protected species and EU Habitats Directive annex species. Found in one location on the route, at the edge of a dry alvar meadow, on an ecotone between the meadow and a mixed forest about 300 m inland from the pipeline landfall point. The location was recorded with one specimen on a rose hip bush. According to the environmental register, there are 37 known sites of the species in Estonia (only three in Harju County, with one in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the location constitutes 3% of the sites in Estonia, 25% of known sites in Harju County and 50% of the sites in Paldiski. According to the environmental register, 20 of the 37 (54%) sites in Estonia are protected; the numbers in Harju County and Paldiski town are 2 (67%) and 1, (100%) respectively.

Bumblebees (Bombus sp), all species are under protection category III. A total of six species and 12 sites were found, all of which are directly in the route impact zone. The species and number of new locations found compared to the existing data in the environmental register is as follows: common carder bumblebee (*Bombus pascuorum*) – three new sites; seven in the register in Estonia (four in Harju County and none in Paldiski). These numbers constitute 30% of the total number of recorded sites in Estonia and 43% of the Harju County findings. The number of sites in protected areas is 4 (57%) and 2 (50%) respectively; tree bumblebee (*Bombus hypnorum*) – one new site; nine in the register in Estonia (four in Harju County and none in Paldiski). These numbers constitute 10% of the total number of recorded sites in Estonia and 20% of the Harju County findings. The number of sites in protected areas is 6 (67%) and 2 (50%) respectively; red-tailed bumblebee (*Bombus lapidarius*) – three new sites; 10 in the register in Estonia (four in Harju County and none in Paldiski). These numbers constitute 23% of the total number of recorded sites in Estonia and 43% of the Harju County findings. The number of sites in protected areas is 8 (80%) and 2 (50%) respectively; buff-tailed bumblebee (*Bombus terrestris*) – one new site; six in the register in Estonia (four in Harju County and none in Paldiski). These numbers constitute 14% of the total number of recorded sites in Estonia and 20% of the Harju County findings. The number of sites in protected areas is 4 (67%) and 2 (50%) respectively; white-tailed bumblebee (*Bombus lucorum*) – three new sites; five in register in Estonia (four in Harju County and none in Paldiski). These numbers constitute 40% of the total number of recorded sites in Estonia and 43% of the Harju County findings. The number of sites in protected areas is (60%) and 2 (50%) respectively; sand bumblebee (*Bombus veteranus*) – one new site; five in the register in Estonia (three in Harju County and none in Paldiski). These numbers constitute 17% of the total number of recorded sites in Estonia and 25% of the Harju County findings. The number of sites in protected areas is 3 (60%) and 2 (67%) respectively.

Formica (Formica sp), all species are under protection category III. Since the group can be difficult to determine as a species, the findings have been recorded on the level of colonies, with only the mounds marked as the site. There are six sites recorded in the route impact area. According to the environmental register, there are 25 known sites of the species group in Estonia (nonein Harju County or in the administrative territory of the City of Paldiski). Therefore, of the sites recorded in the environmental register, the new findings in Kersalu location constitute over 19% of the total sites in Estonia. According to the environmental register, 10 of the 25 sites in Estonia are protected, with a total percentage rate of 40%.

Pakrineeme route (ALT EST 2):

Bumblebees (Bombus sp)**,** all species are under protection category III. A total of three species and six sites were found, all of which are directly in the route impact zone. The species and number of new locations found compared to the existing data in the environmental register is as follows: common carder bee (*Bombus pascuorum*) – two new sites; seven in the register in Estonia (four in Harju County and none in Paldiski), constituting 20% of the total number of recorded sites in Estonia and 33% of the Harju County findings; red-tailed bumblebee (*Bombus lapidarius*) – two new sites; 10 in the register in Estonia (four in Harju County and none in Paldiski), constituting 17% of the total number of recorded sites in Estonia and 33% of the Harju County findings; white-tailed bumblebee (*Bombus lucorum*) – two new sites; five in the register in Estonia (four in Harju County and none in Paldiski), constituting 29% of the total number of recorded sites in Estonia and 33% of Harju County findings; For the protection status of these species, see above.

5.2.8.6 Valuable habitats

Habitats on the Pakri Peninsula are characterized by calcareous and sandy soil, and human impact from the past. Calcareous and sandy soil, along with the outcropping of bedrock as shoreline escarpments, creates the natural basis for the habitats on the peninsula. The habitats are greatly influenced not only by the cessation of extensive former farming activities and military activity that greatly shaped the landscape, but also by mining activities in the open limestone quarries and gravel pits, and lately by the addition of a considerably large-scale wind farm in the area. Former vast alvars have overgrown or even afforested. One-time limestone quarries and gravel pits have become secondary alvars. The broad-leaved Tilio-Acerion forest growing in front of the limestone shore and on slopes, screes and ravines is of significant value. The latter and also vegetated limestone and sandstone banks, together with the shingle and sandy beaches and the alvars referred to earlier are among the habitats protected under the EU Habitats Directive (Natura 2000 sites).

The following EU level of significant habitats has been recorded in or in the close vicinity of the pipeline route impact assessment object area.

Kersalu (ALT EST 1):

There are no EU Habitats Directive habitats in the direct impact zone of the pipeline route. The closest location that meeting the criteria is a dry, sandy patch of meadow of about 300 m² located directly on the pipeline axis for about 7580 m inland from the pipeline landfall point(see habitat number 4 at Figure 5-53), the descriptions of the small pasque flower, tall thrift and common European viper above) and a representative alvar of ½ ha located 300–400 m inland from the pipeline landfall point, covering the whole route impact zone (see habitat number 8 at Figure 5-53 and also the descriptions of the tall thrift and other invertebrates above). The biocoenosis structure of both the meadows referred to are similar to habitat type "6210 – *Festuco-Brometalia* habitats on semi-natural dry grasslands and brushes on carbon-rich soil (* significant orchid habitats)" in the EU Habitats Directive, and both of these habitats are important feeding and living environments for several protected animal species, for example, the northern bat, Nathusius's pipistrelle, bumblebees, Formica, large copper, Epatolmis and scarce fritillaries.

Habitat classification on the route has been outlined in Table 5-20 and in Figure 5-53.

Table 5-20. Habitats on Kersalu (ALT EST 1) route. Column colors indicate the degree of representativity: red – high value, habitat with excellent representativity; yellow – medium value, habitat with good representativity; green – normal value, habitat with non-significant presence. Numbers indicate the habitat patch on Figure 5-53 below.

No	Habitat	Subject surface area, ha	Notes
1	Shallow, buried sandy beach in front of the buried limestone cliff with lots of springs	0.08	**Good representativity**
2	Shallow, buried limestone cliff with lots of springs next to an area dominated by *Alnus glutinosa*	0.06	approx 4–6 m high, **good representativity**, with a thick layer of plant litter and decay
3	Wet meadow on buried, spring-rich limestone cliff	0.12	**Good representativity** as a meadow. Rare species represented are: bumblebees, *Formica* and fumewort; also the habitat for scarce fritillaries, raising the **representativity to above good.**
4	Dry, sandy meadow	0.03	Roof of a limestone cliff, **valuable habitat with excellent representativity,** species: common European Viper, small pasque flower, bumblebees, *Caryophyllaceae*

No	Habitat	Subject surface area, ha	Notes
5	Dry meadowland	0.13	Roof of a limestone cliff, **good representativity**, rich butterfly fauna
6	Middle-aged broadleaf forest	0.64	Secondary forest dominated by broadleaf trees, growing on a former meadow, **habitat with non-significant presence.**
7	Middle-aged mixed forest	0.30	Secondary forest rich in pot holes and animal tracks, but with higher representativity than previous secondary broadleaf forest, **good representativity**
8	Dry meadowland, alvar meadow	0.50	**Alvar meadow with excellent representativity,** home to a large population of tall thrift plants, also many rare butterflies, bumblebees and Formica.
9	Overgrown *Juniperus communis* formations	0.36	Former meadowland, overgrown with bushes and junipers; presence of bumblebees, Formicas and rare butterflies; also animal tracks, **good representativity**
10	Middle-aged marshy alder forest	0.62	Very thick layer of decay and high number of alder trees raises the **representativity**, but it still remains **good**.
11	Young marshy alder forest	0.35	Considerably thick layer of decay and a high number of alder trees raises the representativity, but it still remains **habitat with non-significant presence.**
12	Older forest dominated by *Alnus glutinosa*	0.95	Very thick layer of decay and several hollow and woodpecker trees, forest dominated by *Alnus glutinosa* with **excellent representativity**; presence of animal tracks
13	Grassland	0.27	Species-rich grassland next to a forest; feeding ground to a lot of insect and bird species, **habitat with non-significant presence.**
14	Dry meadowland	0.54	Meadowland with low number of species, **habitat with non-significant presence.**
15	Marshy mixed forest	0.40	Marshy mixed forest rich in micro-habitats; presence of protected plant- and animal species, **good representativity**
16	Middle-aged aspen forest	0.12	Aspen forest **with good representativity**, has the potential to have a higher representative in the future as it grows older.
17	Marshy mixed forest	0.26	Marshy mixed forest rich in micro-habitats; presence of protected plant- and animal species, **good representativity**
18	Marshy mixed forest	0.24	Marshy mixed forest rich in micro-habitats; presence of protected plant- and animal species, **good representativity**
19	Marshy grassland	0.13	Species-rich grassland next to a forest; feeding ground to a lot of insect and bird species, **good representativity**
20	Wet marshy meadow rich in species	0.4	Meadow **with excellent representativity.** Presence of several orchid species and a diverse butterfly fauna; presence of roe deer; elk and wild boar activity tracks

Figure 5-53. Habitats on the Kersalu (ALT EST 1) route.

Pakrineeme (ALT EST 2):

Almost all of the habitats in the direct impact zone of the pipeline route fall under the definition of EU Habitats Directive habitats. Only the shingle-sandy beach by the sea and a patch of dry alvar meadow on the cliff do not meet the Directive criteria (see habitats number 1 and 5 in Table 5-21 and Figure 5-54). However, between these habitat patches are EU Habitats Directive habitats with excellent representativity - vegetated sea cliffs - 1230, a sandstone cliff by the sea and a limestone cliff a little further away (see habitats number 2 and 4 in Table 5-21 and Figure 5-54) and the EU Habitats Directive first priority habitat - Tilio-Acerion forests of slopes, screes and ravines- 9180* (see habitat number 3 in Table 5-21 and Figure 5-54).

Habitat classification on the pipeline route has been outlined in Table 5-21 and Figure 5-54.

Table 5-21. Habitats on the Pakrineeme (ALT EST 2) route. Column colors indicate the degree of representativity: red - high value, habitat with excellent representativity; yellow - medium value, habitat with good representativity; green - normal value, habitat with non-significant presence. The numbers indicate the habitat patch in Figure 5-54 below.

No	Habitat	Surveyed surface area	Notes
1	Shingle-sand beach in front of 3-4 m high sandstone cliff	0.12	Flooded strip of beach, **habitat with non-significant presence.**
2	Sandstone cliff	0.08	Vegetated sandstone cliff with **excellent representativity,** Natura type 1230
3	Broad-leaf forest growing on the cliff litter bank	0.13	Tilio-Acerion forest of slopes, screes and ravines with a thick layer of plant litter, **excellent representativity** Natura type 9180*
4	Limestone cliff	0.03	Vegetated limestone cliff, **excellent representativity,** Natura type 1230
5	Dry meadowland	0.04	Clifftop alvar meadow, **good representativity**

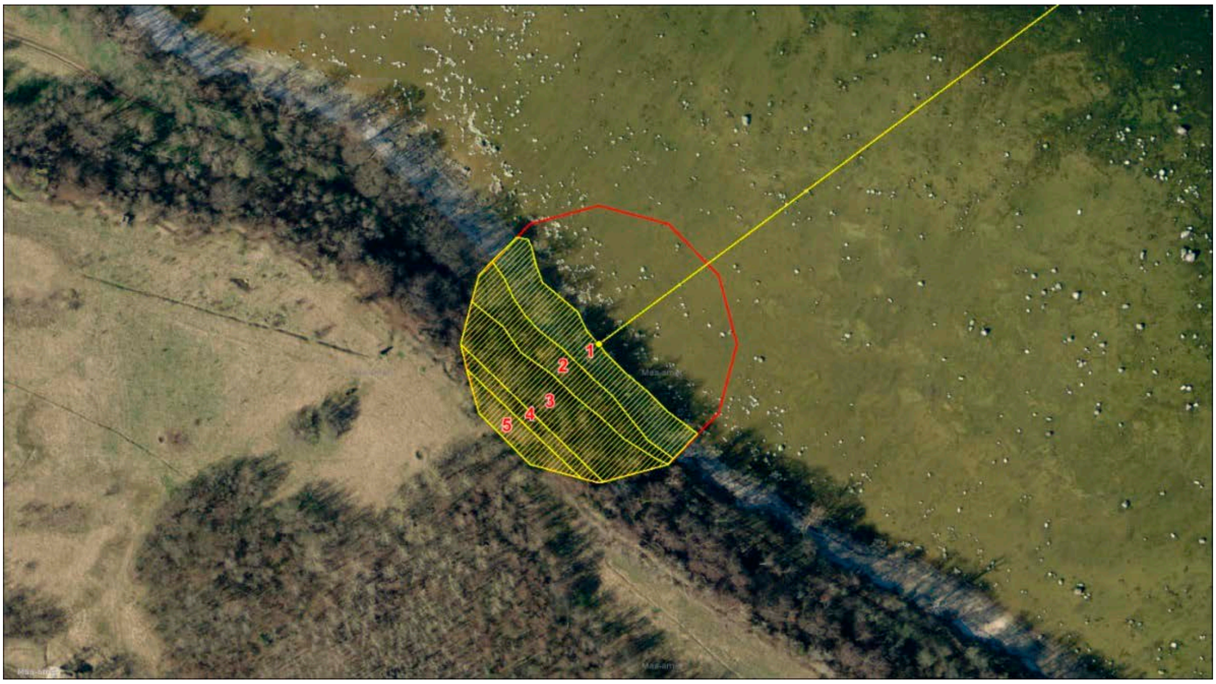


Figure 5-54. Habitats on Pakrineeme (ALT EST 2) route.

5.2.8.7 Green network and valuable landscapes

The thematic plan of Harju County titled *Environmental Conditions Affecting Habitation and Land Use* (*Asustust ja maakasutust suunavad keskkonnatingimused*) was adopted under Order No 365 by Harju County Governor on Feb. 11, 2003 (*Harju Maavalitsus 2003*). The thematic plan is divided into two sections. The first section determines the core sections and corridors of the green network area. The second section conducted an analysis on the cultural landscape based on set criteria and determined the most valuable landscapes. The thematic plan of Harju County titled *Environmental Conditions Affecting Habitation and Land Use* analyzes the location of natural, landscape and other assets in an area, and their impact on each other and the methods to preserve them.

Green network

There is no green network element set in the county thematic plan in the alternative ALT EST 1 pipeline landfall point area.

Alternative ALT EST 2 pipeline landfall point lies directly in an area with a significant value at the county level, as well as possibly at a national level –corridor area no K9.

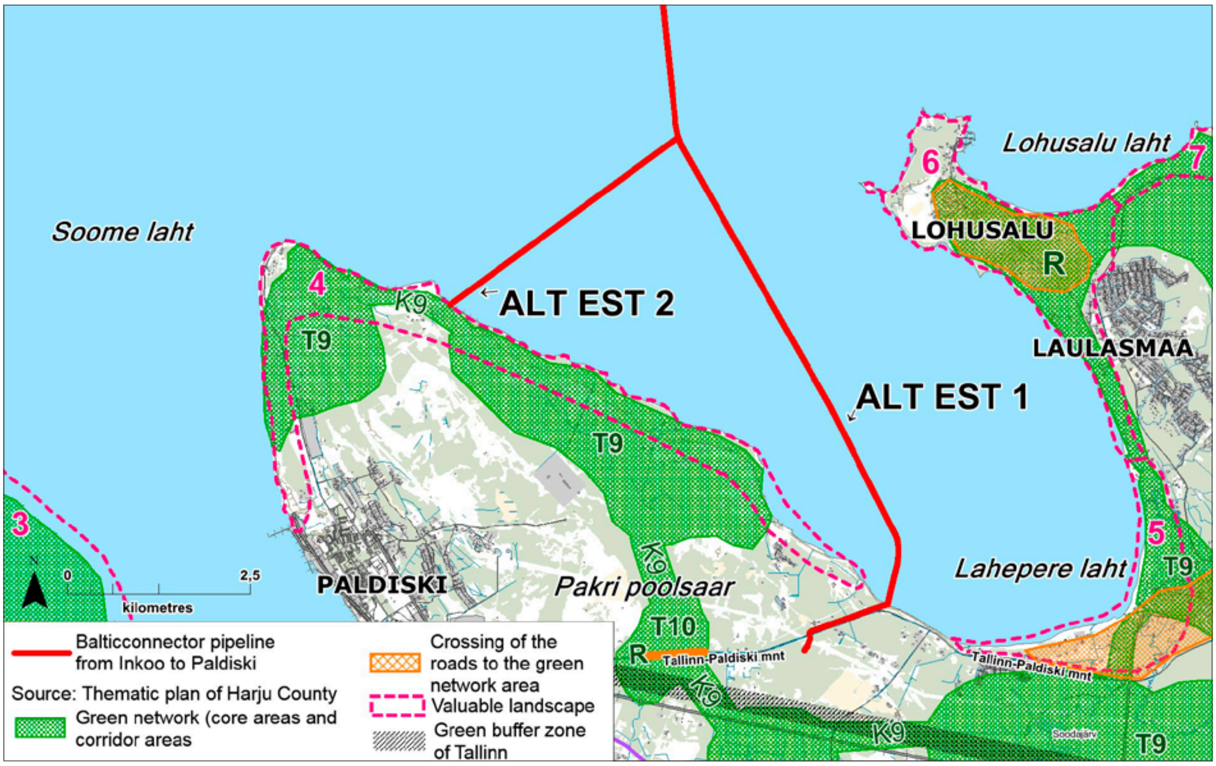


Figure 5-55. Green network and valuable landscapes according to the thematic plan of Harju County titled *Environmental Conditions Affecting Habitation and Land Use* (*Harju Maavalitsus* 2003).

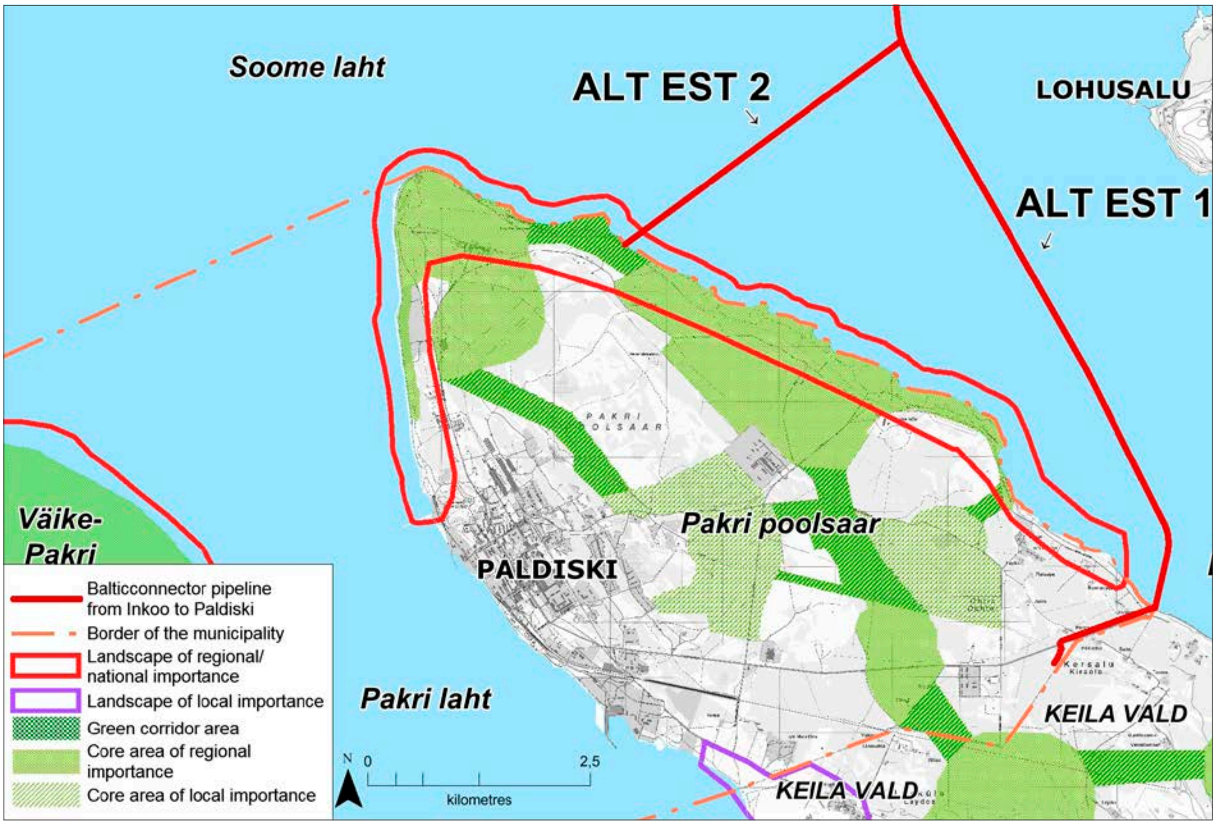


Figure 5-56. Green network and valuable landscapes according to the comprehensive plan of the City of Paldiski (*Entec AS 2004*).

The locations of green network set forth in the thematic plan of Harju County have been further defined in the comprehensive plan of the City of Paldiski (Figure 5-56).

Harju County plan thematic plan imposes general conditions of use on green network areas and corridors which must ensure the functioning of the green network and preserve the valuable landscape.

In plans for a green network area, consideration in all cases must be the continued functioning of the green network.

Green network is definitely one of the criteria determining the choice of construction area. Development activities that change the designated land use or linear developments must be coordinated with the County government and Environmental Board, and environmental impact assessment must focus on the continued functioning of the green network. Certain infrastructure elements cannot be constructed in large core areas and corridors. Where construction is inevitable, the location of development elements must be carefully selected in order to mitigate any negative impact. One option for doing this is to position utility lines next to roads or other linear development objects.

Valuable landscapes

The thematic plan of Harju County defines valuable landscape from the cultural-historical, aesthetic, natural, identity and recreative aspect. These values were used to divide valuable landscapes into three categories:
- landscape of regional and possibly national importance (RN);
- landscape of regional importance (R);
- landscape of local importance (L).

Valuable landscapes must be protected since they are inherent in the national identity, and are a part of the nation's cultural heritage. Valuable landscapes also impact the quality and recreation in the area.

Pipeline route alternative ALT EST 1 in Kersalu does not lie in or close to any valuable landscapes determined by the county's thematic plan.

Natural forest areas alternate with alvars at the Kersalu (ALT EST 1) mainland route by the Tallinn – Paldiski National road. Alvars are located on thin soil, forest stands on thicker soil.

Figure 5-57. Views of the landfall area at Kersalu toward the covered klint scarp and the meadow on mineral soil (alvar) at its foot (*Entec Eesti OÜ 2014*).

Figure 5-58. Views of forest areas and alvars in the ALT EST 1 area at Kersalu by the Tallinn Paldiski highway (*Entec Eesti OÜ 2014*).

The mainland part of ALT EST 1 Balticconnector gas pipeline at Kersalu intersects with the Vana – Tallinn National road, which is the oldest landscape element at Kersalu – constructed in the 18th century and serving as the main road to Paldiski until the 1960s (*Laansoo, 2012*). Nowadays, the Vana Tallinn highway is a gravel road with low everyday traffic intensity. Up until the 1960s, the Vana Tallinn highway was the main road to Paldiski and in the future, there may be a need to use it again in its original use (*Laansoo 2012, Paldiski Municipality 2013*).

ALT EST 1 Balticconnector gas pipeline goes through a number of semi-natural alvar areas near the Tallinn Paldiski highway, and in addition to their natural value, the alvars are part of heritage landscapes. Alvars rich in species have been an inseparable part of traditional Estonian village landscape through the centuries. Most Estonian alvars have been formed out of secondary forest flora as a result of cutting down trees and bushes and further grazing. Alvars are not very common in the world, and thus they are globally rare and need special protection.

Pipeline route alternative ALT EST 2 landfall point is directly located on a valuable landscape of regional and possibly national importance – Pakri Peninsula (valuable landscape no.4 in the thematic plan). It falls under priority class I, its protection level is medium (II) and level of endangerment is also medium (II). According to the thematic plan, the main threats to the area (*OÜ E-Konsult 2003*) are the overgrowing and littering of cliffs and human development (houses, wind generators) in the close vicinity of the cliffs.

Suggested activities for preserving the landscape are: drafting a management plan, subsidizing land management and restrictions on wind generator locations.

The scarp at Pakrineeme at the landfall of ALT EST 2 is on two levels – the upper scarp is steeper and higher 1824 m, and the scarp by the sea is lower – 4 m. The upper scarp – a slate scarp – is very prominent, with vegetation. Broadleaf forest, bank forest, is present on the rubble slope of the slate bank. There are alvars on the bank plateau of Pakrineeme (ALT EST 2).

Figure 5-59. Views of the landfall area at Pakrineeme towards the upper slate scarp and bottom sandstone bank.

Figure 5-60. Views towards the bank forest on the rubble slope of the slate bank, and alvars located on the bank plateau.

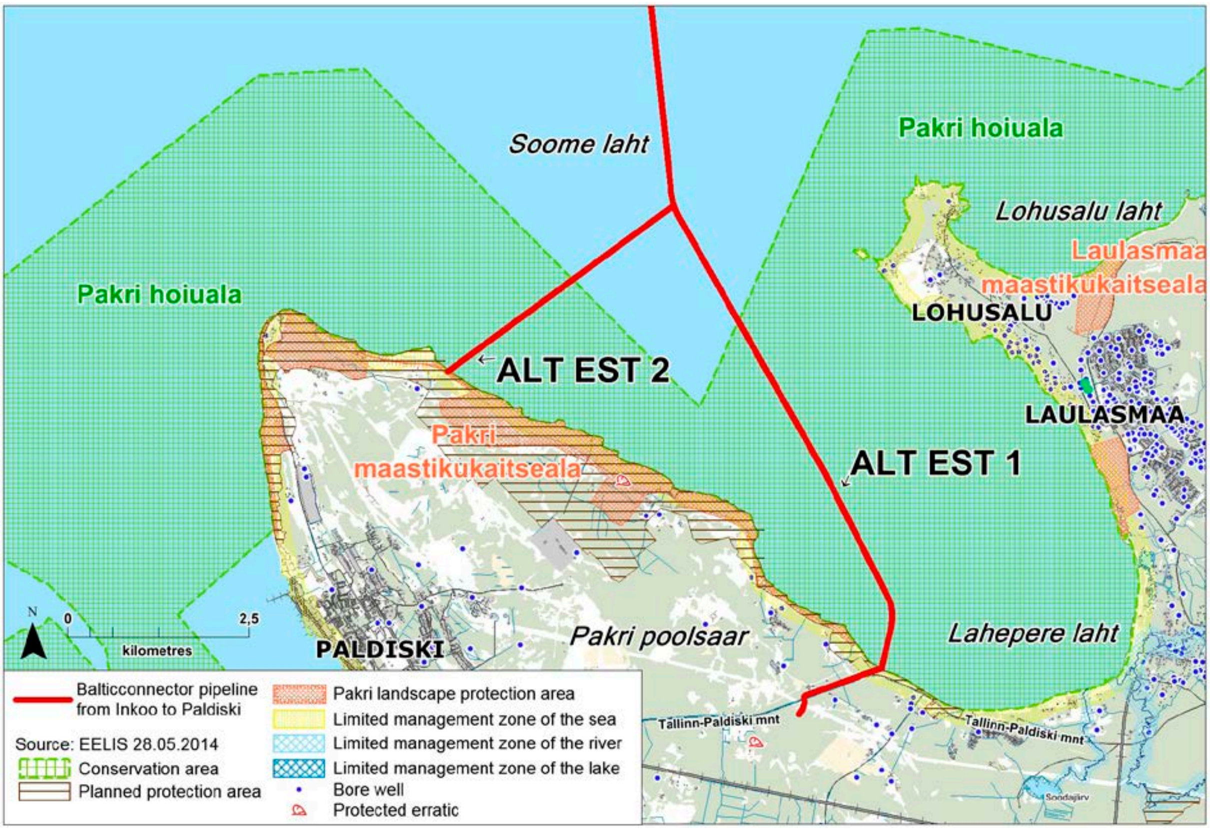


Figure 5-61. Protected natural objects at Pakri Peninsula

5.2.8.8 Protected areas and natural objects

Pakri Landscape Protection Area (KLO1000113)

The descriptive part of the Pakri Landscape Protection Area has been compiled on the basis of data from the Nature Conservation Act, Management Plan of Pakri Landscape Protection Area and Special Conservation Area for 2007–2016 (*Tõnisson 2006*), and the Estonian Nature Information System (*EELIS*).

The Pakri Landscape Protection Area was formed by the Government Regulation No 98 of May 5, 1998, "Placement of Leigri ecological reserve and Pakri Landscape Protection Area under protection, approval of the protection rules and description of external borders". Pakri Landscape Protection Area is in Harju County in the area of the City of Paldiski. The protection area covers most of the limestone bank of Pakri Peninsula and also in separate areas the northern part of Väike-Pakri and Suur-Pakri islands, the sea between the islands, together with Kappa and Bjärgrånne islands, and the southern part of Väike-Pakri Island. Pakri Landscape Protection Area covers 1 459.5 ha. Pakri Landscape Protection Area was formed to protect geological objects of rare and scientific value (outcrops of bedrock, shore walls, boulders), and natural biotic communities.

The Pakri Peninsula represents two types of zones in the protection area : Pakerort special management zone and Pakri limited management zone. (*EELIS*)

According to the protection rules in the Pakri Landscape Protection Area, the following protection procedure applies:

People are allowed to enter and use the entire territory of the protection area, except for the Pakerort special management zone from May 1 to August 31.

Camping and making a fire is allowed only in the designated and marked areas respectively, and on private land with the permission of the owner.

The following is forbidden in the protection area:

1) the construction of new land improvement systems;
2) causing changes in the water level in bodies of water and damaging the banks;
3) driving and parking motor vehicles and floating crafts outside the designated and marked tracks and parking areas, except while performing monitoring, research, and rescue activities, or agricultural and forest activities permitted with these protection rules;
4) shaping pure stands, establishing monospecies forest cultures and energy forests;
5) discharging of waste;

6) hunting and fishing.

Without the permission of the keeper of the protection area, it is forbidden to:

1) change the boundaries and surface area of the land parcels of cadastral units;
2) authorize a land readjustment plan;
3) issue forest readjustment plans to forest owners;
4) adopt detailed and comprehensive plans;
5) issue design criteria;
6) use fertilizers and toxic chemical agents;
7) build roads, overhead transmission lines, and other communications;
8) extract mineral resources and earth material;
9) erect new buildings;
10) carry out geological studies and investigations;
11) organize popular events (with more than 50 participants);
12) final cutting (regeneration cutting), except shelterwood cutting with a period of at least 40 years, whereas the manager of the protected area has the right to set requirements for the time of cutting, sack-up and extraction of timber, and the composition and density of the forest stand.

According to the preliminary natural gas pipeline project, the Kersalu gas pipeline landfall point ALT EST 1 is not included in the Pakri Landscape Reserve, but the Pakrineeme landfall point in ALT EST 2 is (*Ramboll 2014a*).

Pakri Peninsula klint at the pipeline landfall point of of the planned activities is one of the objects of value in the Landscape Protection Area. The klint reaches to a height of 25 m at Pakri Peninsula. According to the Management Plan of Pakri Landscape Protection Area and Special Conservation Area for 2007–2016, the klint of Pakri Peninsula is inthe highest protection category, I.

Waterfalls and springs are an integral part of the Pakri limestone shore and their separation from it is notional. There are six valuable waterfalls on the Pakri limestone shore. Põlde fall is an artificial fall that formed in 2005. Pakri, Kaasiku, and Kersalu falls are in protection category II; Põlde, Valli, and Põllküla falls are in category III.

Springs emerge at several places at the base of the limestone bank, but are more frequent in the area between Kersalu and Leetse. On the east coast of Pakri Peninsula in the Pakri Landscape Protection Area, the Pakri spring area has 12 known springs. The spring area is in the lowest protection category, III.

Of the natural factors, the bank is threatened by landslips due to erosion by the sea. The scarp may also be impacted by mechanical artificial influencers in a 500-m wide zone (radars, wind generators, etc.), commissioning of construction limestone, and construction activities on the bank. Crumbling of the upper edge of the bank and landslips is also advanced by visitors trampling on the plants and turf. Visitor loading should not exceed 40 people per group. However, considering the size of the banks, significant impact by people is unlikely. A visual hazard is littering.

The long-term protection objective of the klint is to ensure the development of it only as a natural process, for which also a sufficient legal basis must be ensured. All kinds of pollution, including visual, must be prevented. The value of the cliff needs to be emphasised more clearly.

Waterfalls are endangered by drainage activities in the catchment area, dredging of the creek bed, extraction of limestone, and directing wastewater to the stream. The conservation aims are the same as with the klint – ensuring the natural development of the falls.

The **springs** are threatened by drainage, construction activities, and the dumping of waste in the limestone gaps. The conservation objective is to maintain the natural regime of the springs.

Boulders and boulder fields

The limited management zone on the Pakri Peninsula includes Pärnsalu II boulder field and boulders, Ubaniidi boulder and boulder field, and Leetse manor and boulders. The large boulders of Leetse (KLO4001228) are a protected natural feature in protection category III. The rest of the large boulders on the protection area can be considered notable objects.

There are almost no hazards to boulders besides natural disintegration. In order to achieve the conservation objective, the surroundings of the larger boulders and the area of boulder fields must be in order.

Pakri Special Conservation Area (KLO2000167)

Pakri Special Conservation Area was placed under protection on June 16,2005 under regulation No 144 of the Government of Estonia "Placing Special Conservation Areas Under Protection in Harju County" (*RT I 2005, 38, 300*). The surface area of the special conservation area is 19,115 ha, 17,037.2 ha of which is the sea (*EELIS*). The mainland section of the special conservation area contains, in addition to the city of Paldiski, also parts of Padise and Keila rural municipalities (on the coast of Paldiski Bay) and the sea areas of these rural municipalities, and Harku rural municipality (*Tõnisson 2006*). The water area of the Paldiski ports is not a part of the special conservation area.

The conservation objective of the Pakri Special Conservation Area is to conserve the habitat types stated in Annex I to Council Directive 92/43/EEC – estuaries (1130), large shallow inlets and bays (1160), drift lines (1210), perennial vegetation of stony banks (1220), Boreal Baltic islands and islets (1620), coastal meadows (1630), grey dunes (2130*), Alpine rivers and their ligneous vegetation (3140), *juniperus communis* formations (5130), semi-natural dry grasslands and scrubland facies on calcareous substrates (6210), Nordic alvar and precambrian calcareous flatrocks (6280*), Calcareous fens with Cladium mariscus and species of the Caricion davallianae (7210*), alkaline fens (7230), natural old broad-leaved deciduous forests (9020*) and deciduous swamp woods (9080), and conservation of the habitats of the species listed in Annex II and in Annex I to the directive 2009/147/EC of the European Parliament and of the Council, and the conservation of habitats of migratory birds not listed in Annex I. (*RT I 2005, 38, 300*).

Species with a protected habitat are the Eurasian Widgeon (*Anas penelope*), Mallard (*Anas platyrhynchos*), Greater Scaup (*Aythya marila*), Eurasian Bittern (*Botaurus stellaris*), Common Goldeneye (*Bucephala clangula*), Black Guillemot (*Cepphus grylle*), Long-tailed Duck (*Clangula hyemalis*), Bewick's Swan (*Cygnus columbianus bewickii*), Whooper Swan (*Cygnus cygnus*), Mute Swan (*Cygnus olor*), Common Gull (*Larus canus*), Velvet Scoter (*Melanitta fusca*), Goosander (*Mergus merganser*), Ruff (*Philomachus pugnax*), Great Crested Grebe (*Podiceps cristatus*), Common Eider (*Somateria mollissima*), Common Redshank (*Tringa totanus*), marsh angelica (*Angelica palustris*), sand pink (*Dianthus arenarius* ssp. *arenarius*), and fen orchid (*Liparis loeselii*). (*RT I 2005, 38, 300*).

According to Sections 14 and 32 of the Nature Conservation Act, the following restrictions and prohibitions apply to special conservation areas (*RT I 2004, 38, 258*):

1) *Without consent of the manager of the protected natural feature, it is not allowed to:*
- *change the boundaries and the intended purpose of the land parcels of cadastral units;*
- *prepare a land readjustment plan and perform land readjustment activities;*
- *adopt a detailed or a comprehensive plan;*
- *agree on small construction activities, including construction of a landing place or a boat landing;*
- *issue design criteria;*
- *issue building permits;*
- *establish a new water body with a surface area of more than five square meters, if there is no need for issuing a special use of water permit, a building permit, or giving an approval for small construction activities;*
- *provide additional food to the game.*

2) *It is forbidden to damage and destroy the habitats and natural sites for conservation of which the special conservation area was formed. The species under protection may not be disturbed significantly, and all activities threatening the favourable condition of the habitats, natural sites, and the protected species.*

3) *Forest cutting is forbidden in the special conservation area if there is a possibility it will damage the structure and functions of the habitat in question and endanger conservation of the species typical to the habitat.*

4) *The impact of the activities planned on the special conservation area to the state of habitats and species shall be assessed in the course of environmental impact assessment or according to the provisions of Section 33 of the Nature Conservation Act (RT I 2004, 38, 258).*

The route of the planned gas pipeline ALT EST 1 will pass through the Pakri Special Conservation Area along a section of approximately 5.3 km and the route of ALT EST 2 along a section of approximately 2.1 km in Lahepere Bay.

Planned protection area

Based on the information received from the Harju – Järva – Rapla region of the Environmental Board, new protection rules for the Pakri Landscape Protection Area are being prepared, whereby the Pakri Landscape Protection Area will be expanded and cover also the ALT EST 1 area. According to the new protection rules, the existing conservation objectives will be supplemented by new ones that comply with the conservation objectives of the Pakri bird and nature area. The impacts of the planned pipeline on the protection objectives of Natura 2000 sites are addressed in section 6.7 of this report.

Single natural objects to be conserved

Boulders

There are several protected boulders on the Pakri Peninsula: Leetse boulders (KLO4001228) (2.7 km from the Pakrineeme landfall point), Neosti boulders (KLO4000119) (0.6 km south of the Pakrineeme landfall point), and the Põllküla boulder (KLO4000943) (1.4 km southwest of the Kersalu landfall point). All boulders come under protection category III. The limited management zone of Neotsi boulders and Põllküla boulder is 10 m (*RT 2002, 79, 1217; RT I 2006, 50, 14*). The Leetse boulders are located in the Pakri Landscape Protection Area and their limited management zone is 50 m (*RT 2003*).

There are almost no hazards to boulders besides natural disintegration. In order to achieve the conservation objectives, the limited management zone around the boulders must be in order (*RT 2003*).

Species under protection

Species under protection have been addressed above in section 5.2.8 based on information from EELIS and the Estonian Environment Agency, and the data received from additional stock taking carried out in 2014 (*Klein 2014*), see also Figures 562, 563 and 564. The 2014 stock taking took place from April to July around the Pakrineeme ALT EST 2 pipeline landfall point within a 50-m radius and about 50 m to both sides of the planned gas pipeline trajectory in Kersalu ALT EST 1. In the course of the survey, different flora and fauna was registered in the area studied, excluding birds.

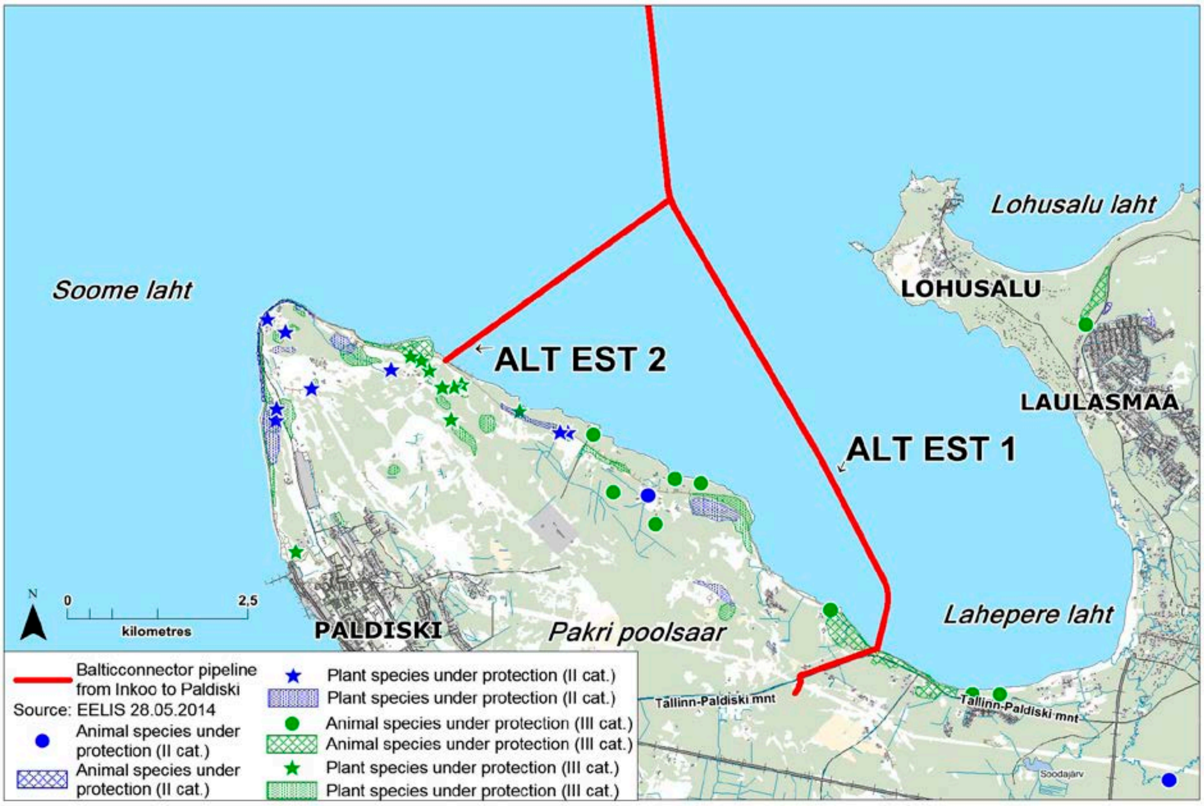


Figure 5-62. Species under protection in the project area according to data from EELIS Environment Agency.

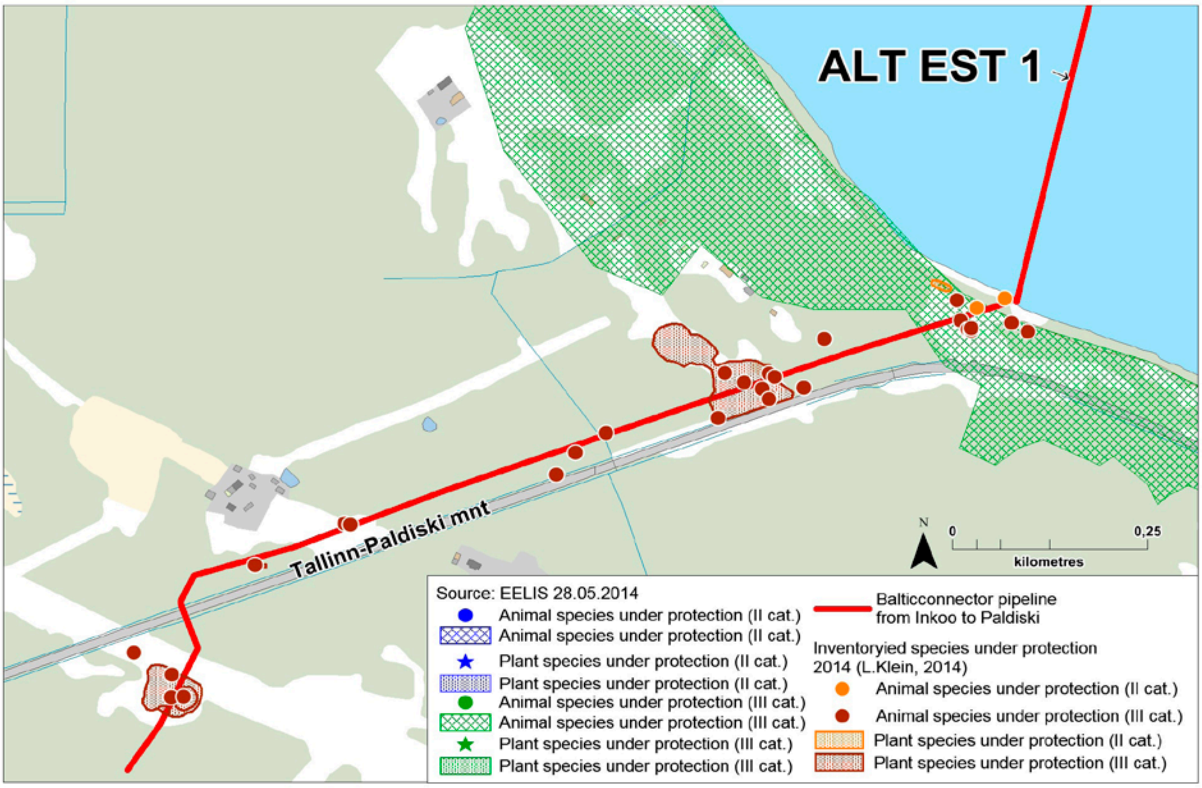


Figure 5-63. Species under protection in the project area of ALT EST 1 according to data from EELIS Environment Agency and to the inventory 2014 (*Klein 2014*).

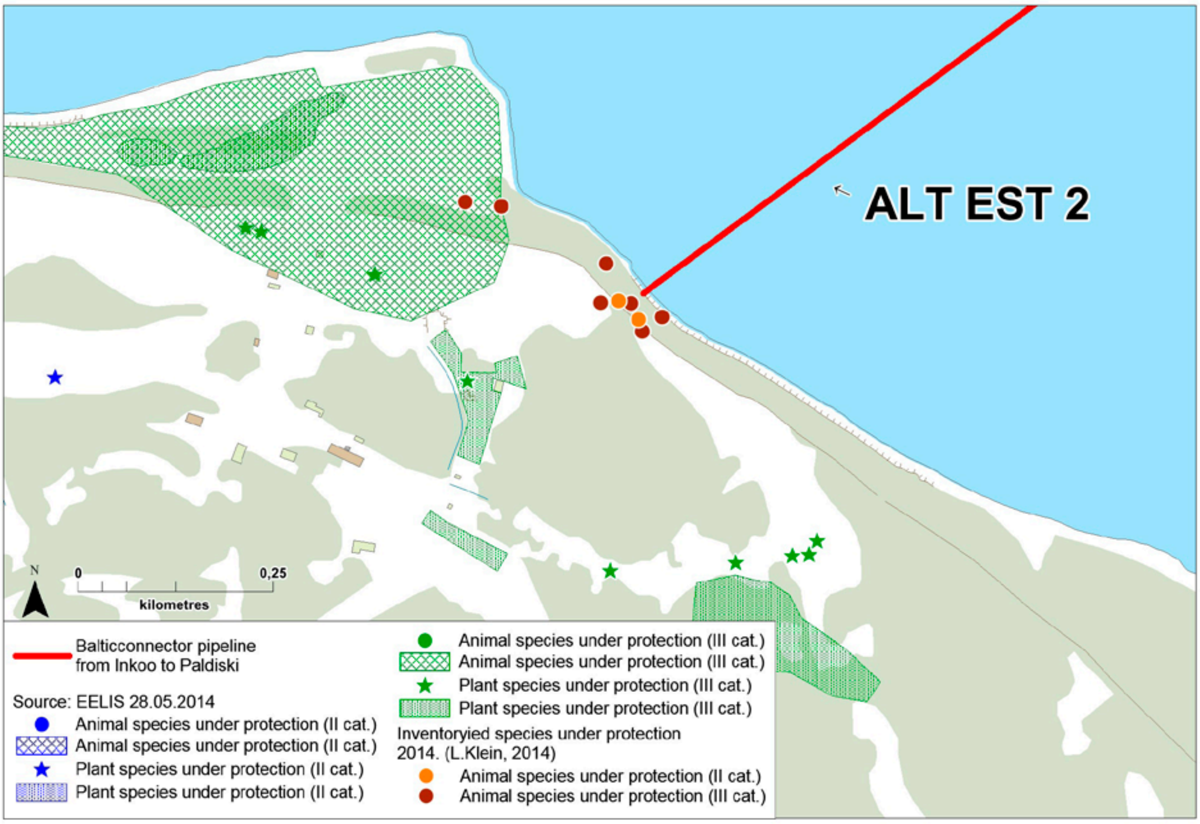


Figure 5-64. Species under protection in the project area of ALT EST 2 according to data from EELIS Environment Agency and to the inventory 2014 (*Klein 2014*).

5.2.8.9 NATURA 2000 sites

Construction of the Balticconnector natural gas pipeline in the sea is planned in the territory of Pakri bird and nature areas (EE0010129) in Estonia, established for conservation of valuable species and habitat types. Pakri bird and nature areas overlap completely and make up an area of 20,574.8 ha, more than 80% of which is the sea. Assessment of Natura 2000 sites has been presented as a separate chapter.

Pakri Bird Area of European Union Importance (PAKRI IBA, CODE: EE070)

Identification of Important Bird Areas (IBAs) in Estonia started in 1991. The European Important Bird Area (IBA) Programme aims to identify, monitor and protect key sites for natural bird species to ensure viable populations. IBAs are relevant mainly for the protection of birds, since they regularly contain one or more globally or regionally endangered species, a local species, or bird communities of excellent representativity.

Pakri Important Bird Area (Pakri IBA) covers 21 036 ha. Based on that IBA, Pakri bird area was formed. The route of the planned gas pipeline goes through Pakri IBA along a section of approximately 5.1 km in Lahepere Bay. Important bird species that correspond to the IBA criteria in this area are the Tundra Swan (*Cygnus columbianus*), Whooper Swan (*Cygnus Cygnus*), Greater Scaup (*Aythya marila*), Long-tailed Duck (*Clangula hyemalis*), and Common Goldeneye (*Bucephala clangula*). The area is important to other water birds as well. Since it is also Pakri IBA, this report did not separately cover the impacts of the planned activities on the area. Impacts to Pakri IBAs are covered in section 6.7.

5.2.9 Socio-economic environment

5.2.9.1 Settlement

Paldiski is a small municipality on the north coast of Estonia, it lies to the west in Harju County on Pakri islands and peninsula. On the mainland, the City of Paldiski is bordered by Keila Parish. Paldiski is located 48 km from Tallinn and 25 km from Keila. The administrative territory of the City of Paldiski consists of the area of the historic Paldiski (town center in its modern meaning), and the surrounding sparsely populated areas on Pakri Peninsula and islands.

The surface area of the town is 60.2 km², approximately 33 km² on the mainland and almost as much on the islands that currently have no permanent settlement (13.5 km² Väike-Pakri Island and 12.5 km²

Suur-Pakri Island). In terms of its size (102 km²), it is the second largest town in Estonia.

The City of Paldiski has a population of 4,067 (as at January 01, 2014). One third of the residents of Paldiski are Estonians, and two thirds of a nationality that speaks some other language (mainly Russians).

Ports and industrial undertakings form the core of development of the City of Paldiski. Pakri Peninsula is suitable for the production of wind energy. The first wind turbine was connected to the grid on December 5, 2004. The wind farm has expanded over the years, and currently it consists of more than 20 active wind turbines.

There are two ports in the administrative territory of the City of Paldiski Paldiski Northern Port and Paldiski Southern Port. As a rule, the ports are ice-free throughout the year and mostly handle goods. The Southern Port also services ferry lines in the direction of Finland and Sweden.

The population of the city of Paldiski is concentrated in the western part of the peninsula – city center. The main residential area is at the center of the local government quarter in the western part of Pakri Peninsula and mainly consists of apartment buildings. Population density is low outside the city. Due to its military history and vast industrial areas, there are very few summerhouses in the area.

There are several establishments of social infrastructure in the center of Paldiski: comprehensive schools, hobby schools, kindergartens, sport facilities, a library, a family health center, and two churches under heritage conservation. There are also several undertakings providing everyday services, and commercial and manufacturing enterprises. One of the most valued tourism attractions of the town is the museum of Amandus Adamson, a famous sculptor in Paldiski.

5.2.9.1.1 Overview of the development of settlement in the City of Paldiski and in the areas covered by the project

The first written record of settlement around Paldiski is from 1377, and refers to Pakri (Packer, Pakre) fishing village (*Entec AS 2004*). The town of Paldiski developed next to a military port established in the 18th century by Peter the Great. In 1762, the settlement was named Baltiiski Port from which the present-day name Paldiski is derived. In 1783, Paldiski was declared a town.

In 1939, the entire population was evacuated from Paldiski. For the next 50 years, it became a closed Russian military town, and the local people were deported. In addition to submarine soldiers, also border guards, (study complex, guard station, radar station), torpedo boats, constructors, and an anti-aircraft unit settled on the peninsula, also including ballistic missiles with nuclear warheads, and submarines. To establish a local government, the Paldiski district of the town of Keila was formed on May 15, 1994 on the territory of Pakri Peninsula and the islands (at this time, also the last Russian military ship left the area). Since October 20,1996, the City of Paldiski has been an independent local government unit.

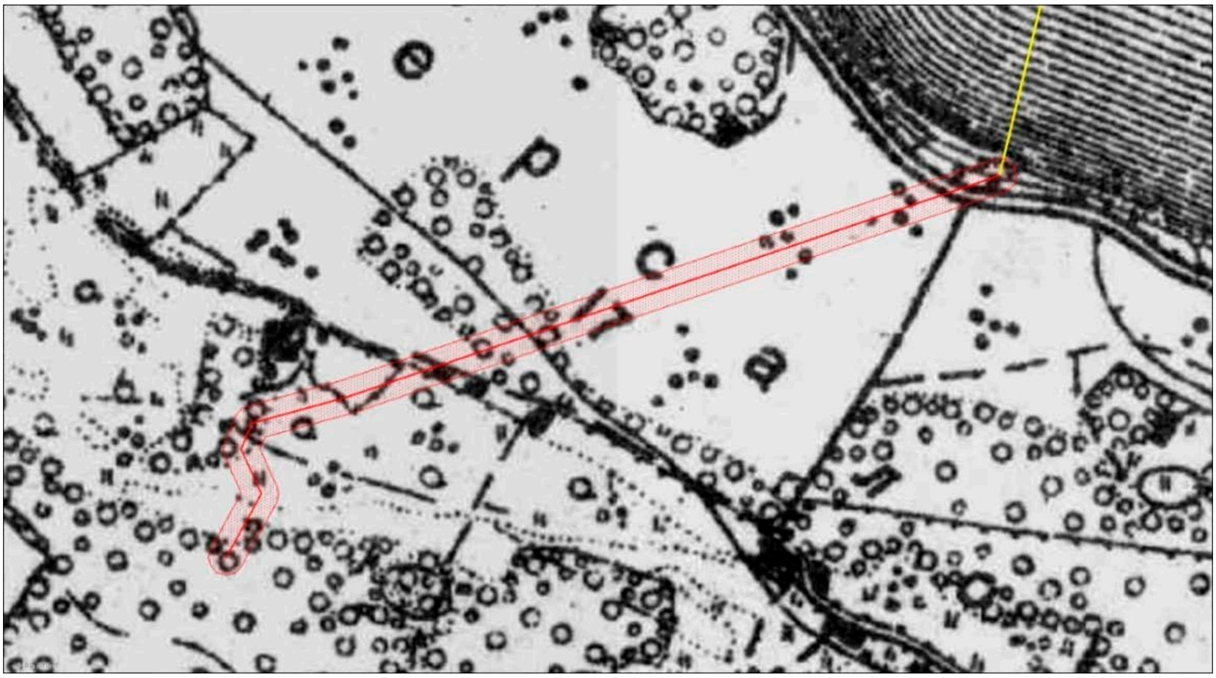


Figure 5–65. Location of the Kersalu pipeline landfall pointon a Russian 1-verst (1:42 000) topographic map (1894–1915, 1919–1934).

Development of Kersalu settlement

Figure 5–65 shows the Vana Tallinn highway and the old road of Madise-Põlluküla (*Maa-amet 2014*). The ALT EST 1 Kersalu pipeline landfall point and the section of the land pipeline will be located in close proximity to the intersection of these roads. The Madise-Põlluküla road also connected the Vana-Tallinn highway to the road to Kersalu village. The Vana-Tallinn highway was built in the 18th century and until the 1960s, it was the main road for entering Paldiski (*Laansoo 2012*). Buildings and ditches, forest and meadow areas and shrubberies as important elements are also visible. Already on the Russian 1-verst map, the buildings of Vanaaseme, Paistu, Põlluotsa, Sepa, and other farmsteads can be seen.

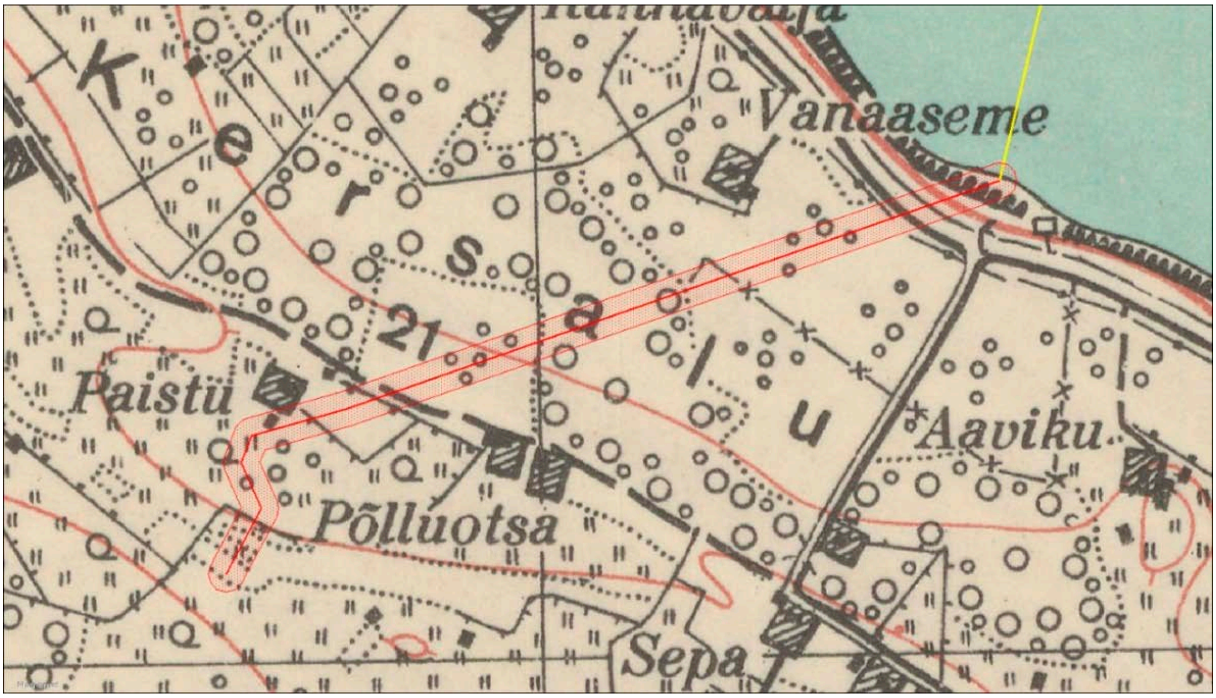


Figure 5–66. Location of ALT EST 1 Kersalu landfall on a topographic 1:50 000 map (1935–1939) of the Republic of Estonia.

The important elements like roads, constructions and ditches, forest and meadow areas and shrubbery shown in Figure 5–66 do not differ significantly from those seen on the Russian 1-verst map.

Before WW II, in October 1939, Soviet marine forces landed in Paldiski and, under the Soviet–Estonian Mutual Assistance Treaty, the population was evacuated (*Entec AS 2004*). After WW II, Paldiski became a Soviet military base. At first, the town was partially open to local people, but after the 1962 decision to establish a USSR nuclear submarine training base in Paldiski, the civilian population was fully deported from the entire Pakri Peninsula within three years. For the next 50 years, Paldiski was a closed military town (*Entec AS 2004*).

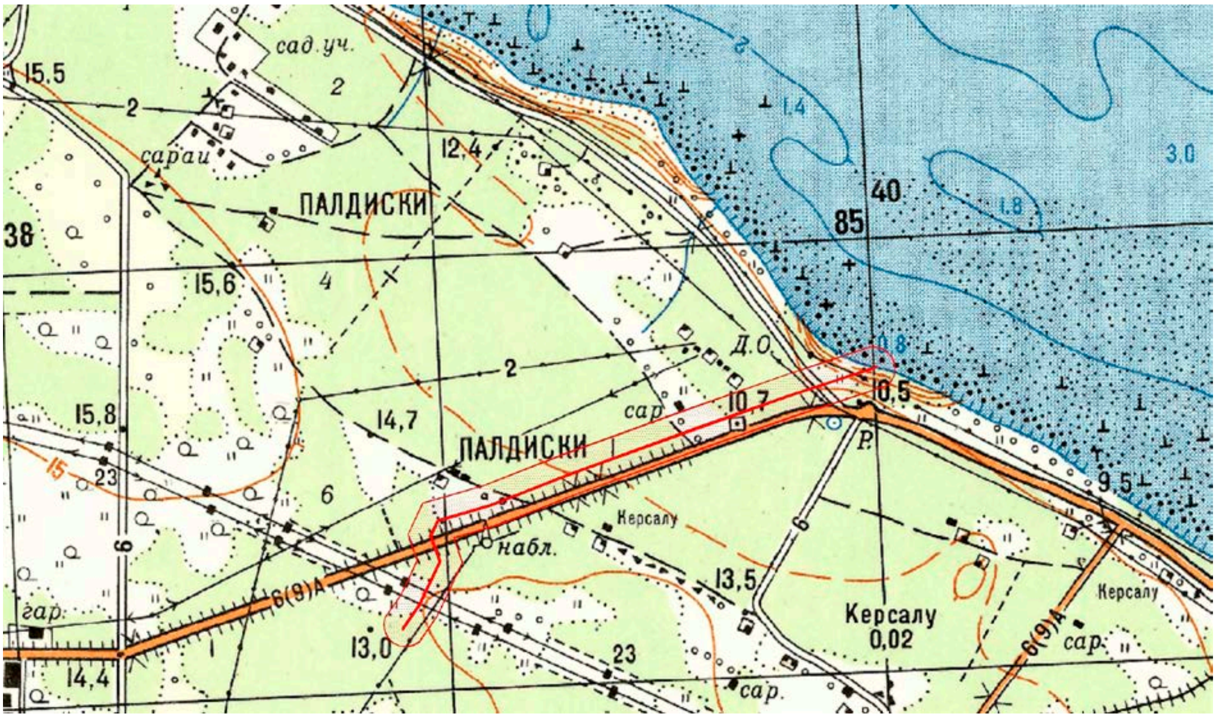


Figure 5–67. Location of ALT EST 1 Kersalu pipeline landfall point on an o–42 series topographic map (1987) of the USSR.

Figure 5–67 shows the changes in road infrastructure today's Tallinn Paldiski main road was built in the 1960s (*Laansoo 2013*). The farm buildings of Vanaaseme have been replaced by military objects.

Similar data on the roads and buildings also appeared on the 1961 topographic map of the USSR, but since in the 1960s, Paldiski became a submarine training base of cross-Union importance, numerous large-scale construction activities were carried out – vast changes in the road network, the building of several technical structures (railway beds, the nuclear object for the submarine soldiers, and a training building in the center of Paldiski).

After Estonia regained independence (*1991*), the Soviet army left Paldiski as late as 1994. It left the town in a miserable state with a high level of environmental pollution, destroyed infrastructure, and a highly complicated demographic situation (*Entec AS 2004*).

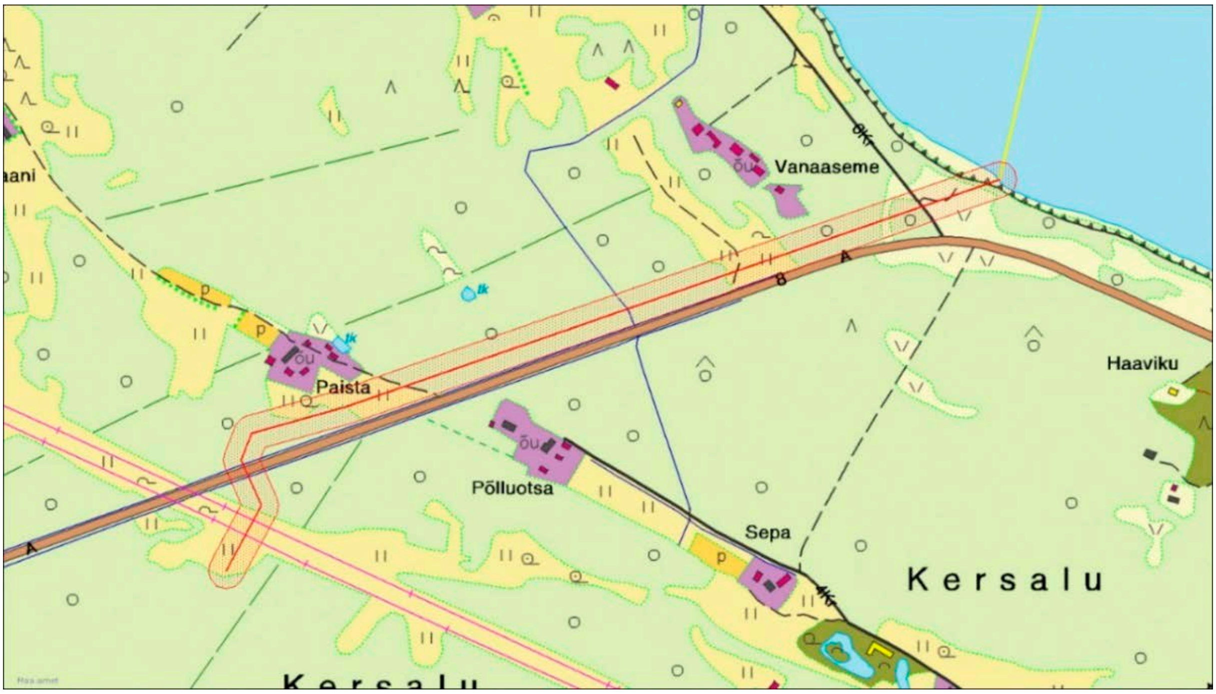


Figure 5-68. Location of ALT EST 1 Kersalu pipeline landfall point and the mainland area on the main map used in 1996-2007.

Figure 5-68 shows the large-scale changes in the location of the roads. Also the forest and meadow areas and the ditches are clearly visible. The most important changes have taken place in the forest and meadow areas in the middle and towards the seaward side of the line.

Figure 5-69. Location of the ALT EST 2 Pakrineeme landfall pointon a Russian 1-verst (1:42 000) topographic map (1894-1915, 1919-1934).

Development of settlement in Pakrineeme

The Russian 1-verst map above (Figure 5-69) shows the landfall point area as being uninhabited; the road on the klint along the shore can be seen vaguely. The population is sparse around the area; the closest signs of settlement are the buildings west of the landfall. The village road is winding and connects farmyards.

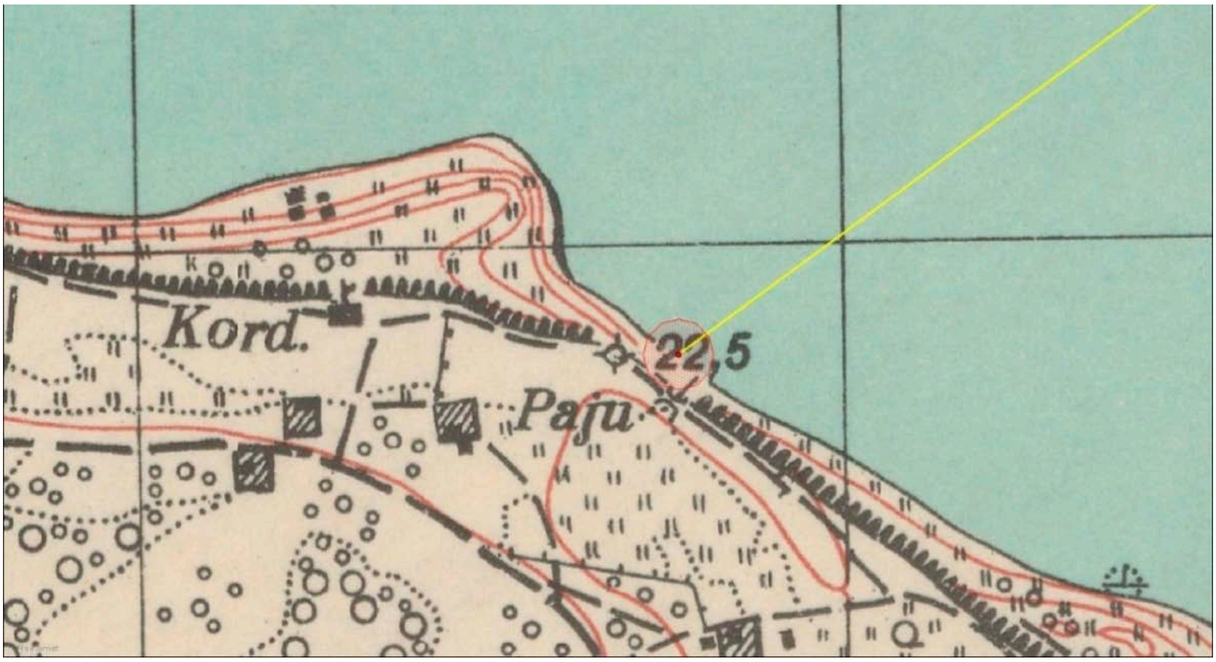


Figure 5-70. Location of the ALT EST 2 Pakrineeme landfall on the topographic map used in 1923–1935.

Figure 5-70 above shows that important elements like roads, constructions and ditches, forest and meadow areas and shrubbery do differ significantly from those seen on the 1-verst map. However, there are still changes in the meadow area and, as an interesting element, a ditch can be seen in the limestone klint.

Figure 5-71. Location of the ALT EST 2 Pakrineeme landfall point on the main map used in 1996–2007.

Figure 5–71 above shows changes in the range and location of the forest and meadow areas and the shrubbery. When in the early 20th century, the area of the klint was marked as a meadow, it and the former meadows on the klint were clearly forested. There is also a new road under the klint. The farms have been replaced by military objects.

The main historical difference between the alternatives studied is that while the ALT EST 2 Pakrineeme pipeline landfall point area has largely remained untouched by human activity through the years (excluding the historical road on the shore which had no significant impact on the natural biotic communities; the impact has increased only recently when motor vehicles are being used on the dirt road), whereas the ALT EST 1 Kersalu area has seen several changes due to human activity – the original road infrastructure has changed completely, as has the land use. Several former meadow areas are no longer used. The greatest change in the land use pattern of the settlement has been the building of the Tallinn-Paldiski National road. Although several old farmsteads have not been repopulated since Estonia regained independence, the old land use pattern and village structure with its elements can be observed in the landscape.

5.2.9.1.2 Settlement overview in Kersalu

ALT EST 1 area is located at the border of the City of Paldiski and Keila Parish next to Tallinn-Paldiski highway (National road 8). The center of the City of Paldiski is located approximately 10 km from ALT EST 1; Keila is approximately 15 km away. The Kersalu area is sparsely populated, but its location in a naturally beautiful area by the sea gives it potential to become a residential area or holiday destination. According to the comprehensive plan of the City of Paldiski, Kersalu is a promising residential construction area at Lahepere Bay. It will be a new residential area which has been actively developed in recent years, and which consists of family and row houses with all the necessary communications (*Entec AS 2004*).

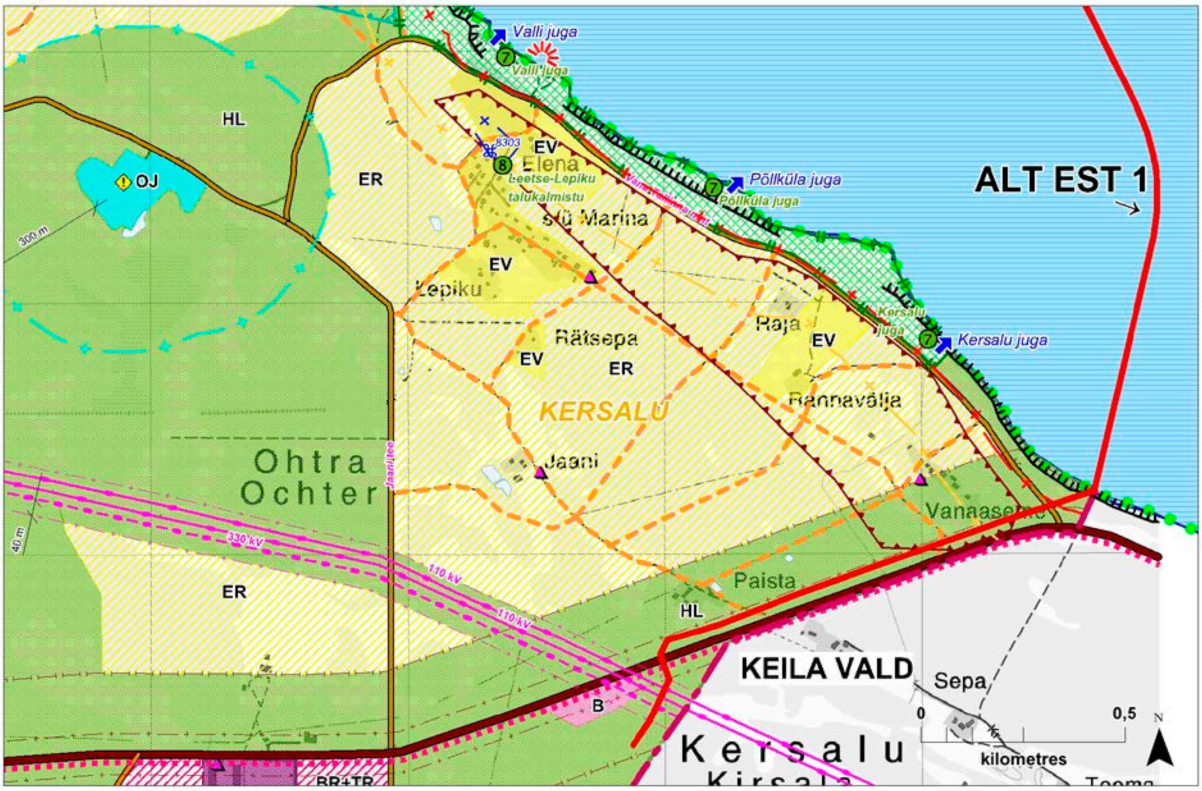


Figure 5–72. Extract of the valid comprehensive plan of the City of Paldiski (*Entec AS 2004*).

According to the comprehensive plan (Figure 5–72), the ALT EST 1 landfall point, together with the section of the pipeline route that is on the land is located in a natural greenery and conservation greenery area (HL) that acts as a buffer zone for Tallinn-Paldiski highway (National road 8). In the **c**omprehensive plan of the City of Paldiski, the new residential areas is located in the area between the Vana-Tallinn highway, Jaani road, and Tallinn-Paldiski highway. Existing residential areas (EV) and future residential areas (ER) are located in the area between Vana-Tallinn highway, Jaani road, and Tallinn-Paldiski highway.

Information on the adopted detailed plans for ALT EST 1 is shown in Table 5–22 and Figure 5–73. No detailed plans have been initiated or adopted in Keila Rural Municipality, in the zone of 1 km from natural gas pipeline.

Table 5-22. Detailed plans at the ALT EST 1 Kersalu pipeline landfall point and the mainland area.

No	Name	Time of initiation/ time of adoption	Objective
1	Detailed plan of Jaani registered immovable	March 28, 2001/ March 13, 2008	Registered Jaani immovable in the detailed plan consists of two cadastral units: 58001:001:0160, area 1.32 ha, commercial land; 58001:007:0370, area 23.51 ha, profit yielding land. The plan suggested dividing the area of the plan to smaller land units to form separate plots: - for a plot with an intended purpose as commercial land; - an existing residence; - corridors of high voltage power lines; - 5 plots with an intended purpose as profit yielding land.
2	Detailed plan of the Vanaaseme registered immovable	September 14, 2006/ June 26, 2014	The planned area covers cadastral units in the City of Paldiski at addresses Vana-Tallinn mnt 5 and Vana-Tallinna mnt 6. The size of the plans in total is approximately 17 ha. With the plan, the area is divided into 15 new residential land plots of the sizes of approximately 5000 – 9800 m2 with the building right to build a detached house and supporting buildings. The nearest planned residential building is approximately 80 m from the Balticconnector gas pipeline.
3	Detailed plan for compressor station for category D gas pipeline	May 23, 2012/ - October 20, 2014	The purpose for preparing the detailed plan is to form a plot and assign building rights for constructing a compressor station needed to exploit the Kiili-Paldiski D-category gas pipeline, and the structures needed to support its work.

Kersalu ALT EST 1 pipeline landfall point and the land section – from the pipeline landfall point to the compressor station – is currently surrounded by natural forest areas alternating with meadowlands. The arable lands and pastures of the former farmsteads have been fallow/uncut for almost 60 years, and are partially covered in brushwood. There are three farmsteads around the on-ground section of the gas pipeline ALT EST 1 from the landfall point to the compressor station:

- Tallinna mnt 51, 51a and 53 properties – distance from the nearest residential building to the natural gas pipeline is approximately 62 m;
- Tallinna mnt 56/ Korka and Vanaranna tee 37, in Keila Rural Municipality – distance from the nearest residential building to the natural gas pipeline is approximately 90 m;
- Vana Tallinna mnt 5 – distance from the nearest residential building to the natural gas pipeline is approximately 80 m;

The buildings have largely been in the same location since the beginning of the 20th century (partially replaced by military structures). The structure of the registered immovables is sparse. The farmsteads are located in a row next to the former village road, or in groups away from the road. On one of these former farmsteads – Vanaaseme registered immovable, a detailed plan has been adopted for expansion of the residential area (Table 5-22). At the same time, the residential building area is yet to be developed.

Kersalu ALT EST 1 pipeline landfall point and the land section – from the landfall point to the compressor station, passes through a total of eight land units, 4 of which are still separate plots of land owned by the State, three privately owned plots of profit yielding land, and one a cadastral unit of land designated for transport. An overview of the ALT EST 1 landfall point and the cadastral units around the land section is shown in Figure 5-74.

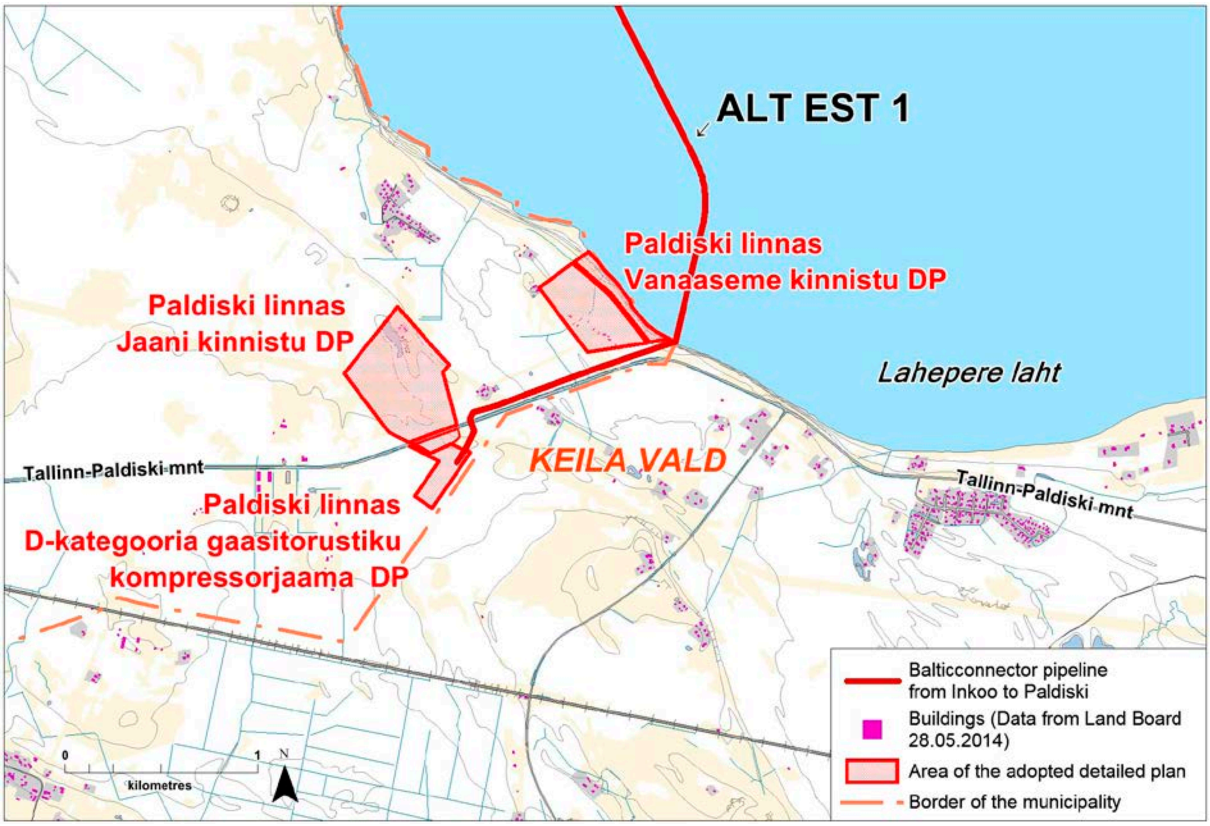


Figure 5-73. Extract of detailed plans adopted in Kersalu.

Table 5-23. Cadastral units in the area of the Kersalu ALT EST 1 pipeline landfall point and the mainland section of the gas pipeline.

No.	Address of the cadastral unit	Register number of the cadastral unit	Intended use	Size of the cadastral unit
1-4	Settlement unit No. 0580	-	-	-
5	Tallinna mnt 61	58001:007:0023	100% profit yielding land	1.54 ha
6	Tallinna mnt 57	58001:007:0022	100% profit yielding land	4.92 ha
7	Tallinna mnt 55	58001:007:0005	100% profit yielding land	1.98 ha
8	8 Tallinn-Paldiski roadway	58001:001:0132	100% land designated for transport	16.97 ha

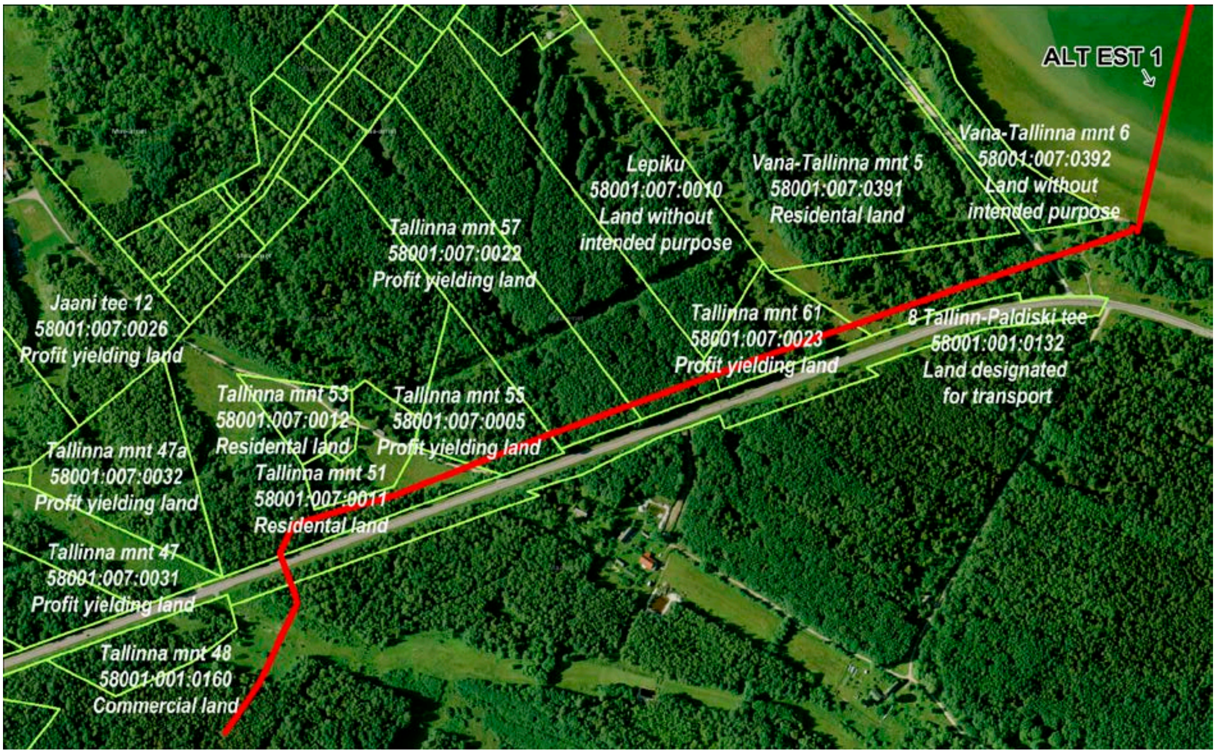


Figure 5-74. Cadastral units in the area of the Kersalu ALT EST 1 pipeline landfall point and the mainland section of the gas pipeline (*Estonian Land Board 2014*).

5.2.9.1.3 Settlement overview in Pakrineeme

The area of the ALT EST 2 Pakrineeme pipeline landfall point is to the east of the tip of Pakri Peninsula, where a large part of the Pakri Landscape Protection Area is located.

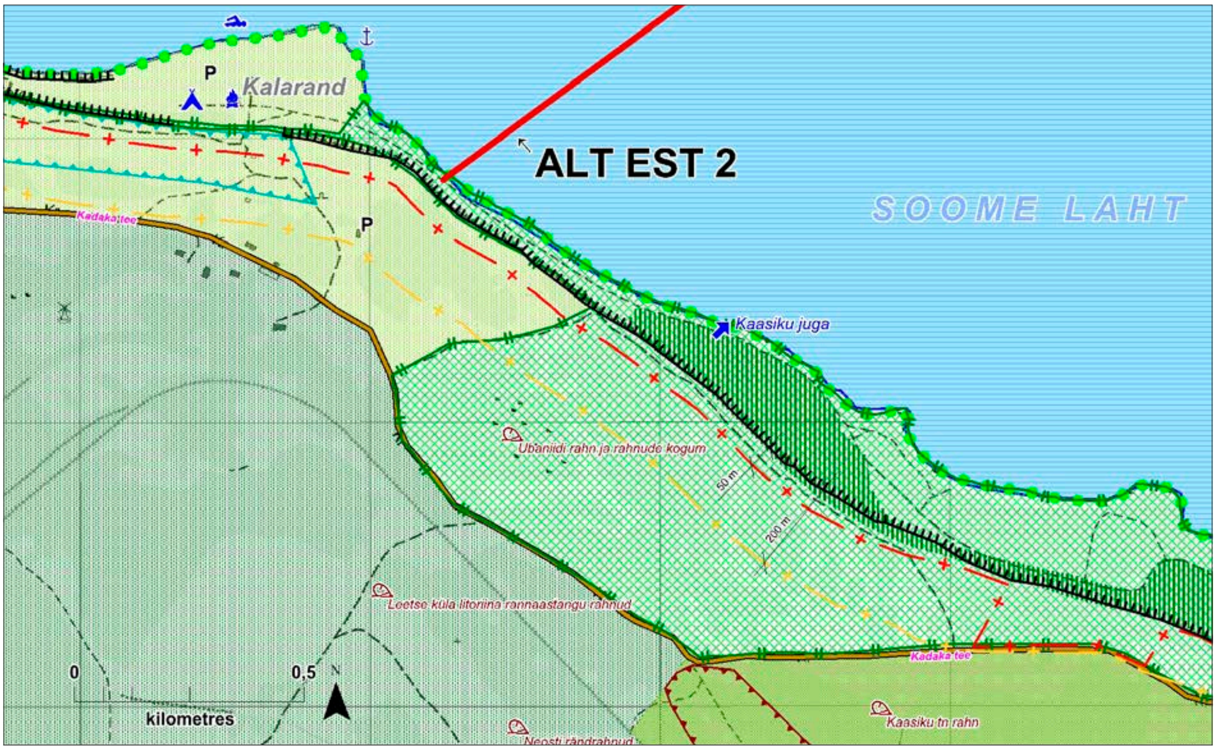


Figure 5-75. Extract of comprehensive plan of the City of Paldiski (*Entec AS 2004*).

According to the comprehensive plan of the City of Paldiski (Figure 5–75), the area is close to the Neeme that was reserved as a recreational area by the comprehensive plan adopted in 2004 (P – recreational and leisure area), but the comprehensive plan has since been amended by thematic and detailed plans – the Paldiski LNG terminal is planned to be built in a part of the recreational area (the thematic plan is adopted by the September 27, 2012 decision No 5 of Paldiski city government; the detailed plan of the mainland section of LNG was adopted by the May 22, 2014 Decision No 21 of the Paldiski city government). More information on the projects related to the planning and building of the LNG terminal can be found in section 6.11.2.1. Paldiski wind farm is also close to the ALT EST 2 pipeline landfall point– the closest wind turbine is approximately 400 m from the landfall.

Landfall ALT EST 2 in Pakrineeme is located in the area of the adopted detailed plan of Paldiski LNG terminal (see also Table 5–24), in the property known as Male (Plot position No 03C in LNG terminal detailed plan). According to the adopted detailed plan, the maximum size of the building right area is 12,000 m✣ in Male property (Figure 5–76). The detailed plan of the LNG terminal provides that all the planned buildings, civil engineering works and infrastructure must be located within the determined building area. The exact position of the buildings, civil engineering works and infrastructure inside the determined building area, will be specified with the building design documentation.

Information aboutthe adopted and initiated detailed plans for ALT EST 2 are shown in Table 5–24 and Figure 5–77.

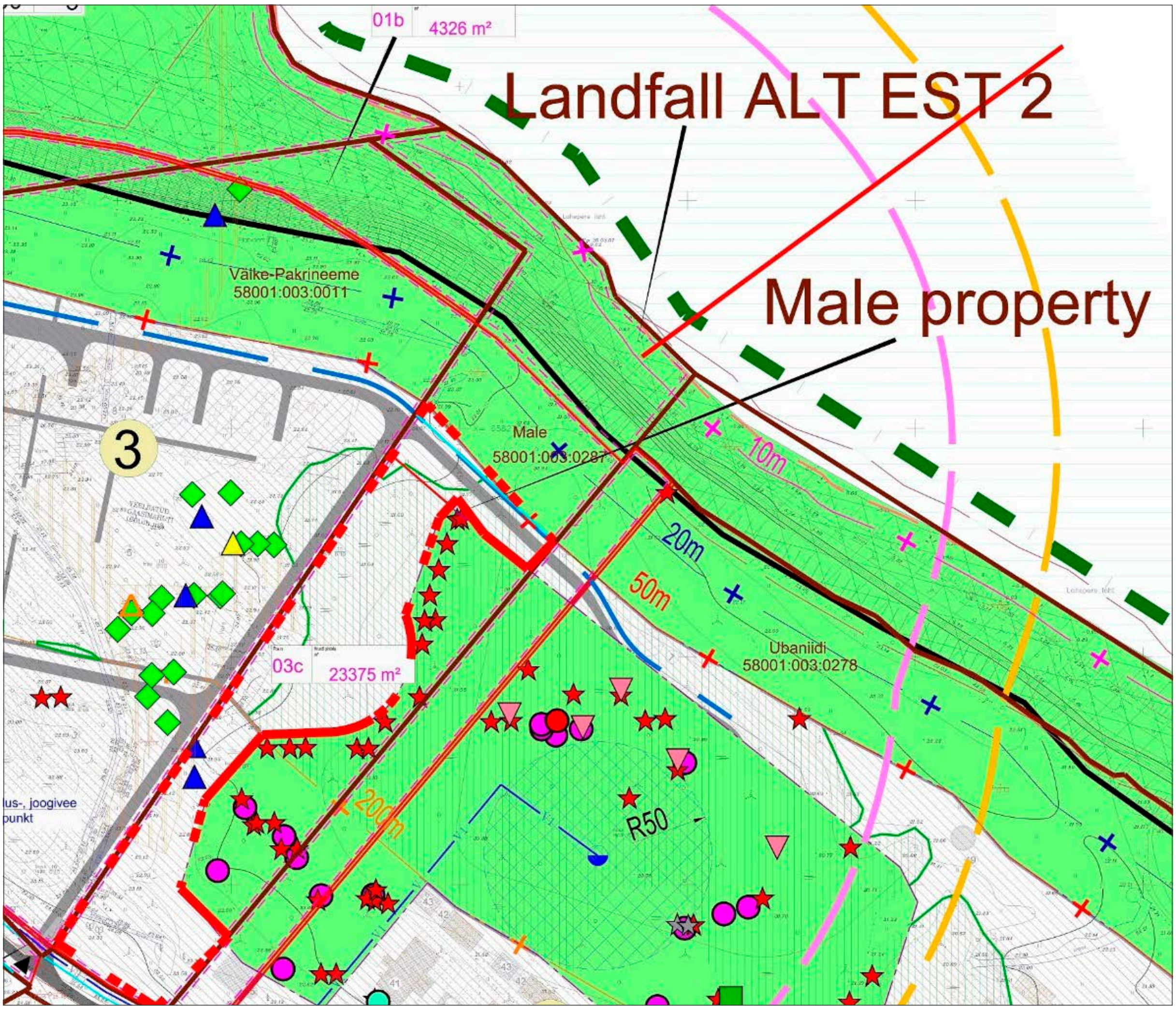


Figure 5–76. Extract of the Paldiski LNG terminal detailed plan. The determined building area of the Male property is shown by the bold red dash-line (*Sweco Projekt 2014*).

Table 5-24. Detailed plans in the area of the ALT EST 2 Pakrineeme landfall point.

No	Name	Time of initiation/ time of adoption	Objective
1	Detailed plan of the mainland section of Paldiski LNG terminal	1.10.2012/ 22.05.2014	The objective of the detailed plan was to amend the borders of the registered immovable, a more accurate determination of the building rights for constructing the LNG terminal and the servicing buildings, finding solutions for technical communications and the regulation of traffic, determining of the environmental conditions. Building of the LNG terminal and its location has been determined by a decision from September 27, 2012 No 5 by Paldiski city government „Thematic plan of the Paldiski LNG terminal".
2	Detailed plan of Paldiski wind farm	16.11.2004 / 12.08.2009	The area of the detailed plan (cadastral units 58001:003:0048, 58001:003:0029) with the surface area of 313.5 ha is in the centre of Pakri Peninsula. The purpose for preparing the detailed plan was to determine the construction rights and solve technical communications for the purposes of building wind turbines.
3	Detailed plan for the berth of LNG terminal in Paldiski	1.10.2012	Currently, only a draft project exists.
4	Detailed plan on division of the Tuulepargi registered immovable in the town of Paldiski	24.11.2012/ 16.05.2014	The planned area covers the registered immovable of the wind farm (cadastral register number 58001:003:0048) and its total size is approximately 252 ha. The objective of preparing the detailed plan was to divide the planned registered immovable to two and to find a way to access these registered immovables on the basis of the existing roads.

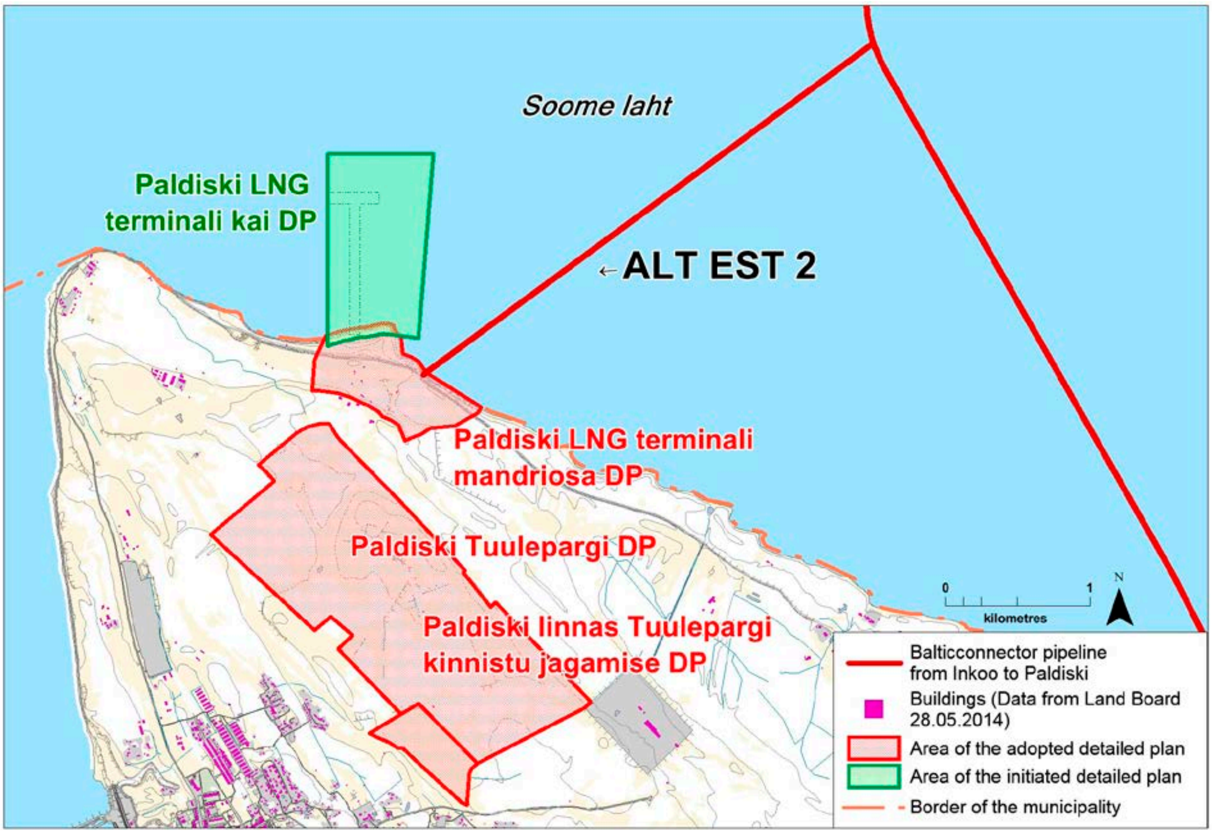


Figure 5-77. Extract of detailed plans adopted and initiated in Pakrineeme.

The Pakrineeme pipeline ALT EST 2 landfall point will be located in the Male registered property (cadastral unit code 58001:003:0287, 100% commercial land, size 2.98 ha).

5.2.9.2 Traffic

Paldiski is surrounded by the parishes of Keila, Padise and Vasalemma. It has good road and railway connections with the rest of the country. National road 8 is the main road connecting Paldiski. Two ports – Northern and Southern are located in the western part of Pakri Peninsula. Both are ice-free throughout the year and handle different types of shipments. There are ferry connections with Finland and Sweden from the Southern port of Paldiski.

According to the Road Administration, the traffic counts on state roads are applied to determine service levels and traffic safety measures. There is a set of traffic density data for the road section where the gas pipe will be located (40,33 – 45,67 km). Since 2011, traffic density has increased by 18.5% on 2013. Heavy vehicles – truck trailers and buses account for one fifth of total traffic load.

5.2.9.3 Communications

According to the information in the comprehensive and detailed plans the following technical communications are located in the mainland part of the ALT EST 1 gas pipeline route:

- At the area of the intersection of Vana-Tallinn highway and Tallinn-Paldiski National road there are two underground communication cables – a copper communication cable and a fiber-optic communication cable. In future the category D pipeline compressor station planned in Kersalu is to be connected to Elion's fiber-optic cable. The length of the planned cable line is ca. 1300 m. The installation depth of the communication cable under the road will be a minimum of 1.0 m, outside the road it is 0.7 m. (*K-Projekt Aktsiaselts 2014*);
- The mainland section of the ALT EST 1 gas pipeline will, toward the category D pipeline compressor station for natural gas, partly cross, the existing 110kV overhead power lines and the planned 330kV overhead power line.

There are two geodetic marks (code numbers: 63-713-1260 and 63-713-1259, classified under class 3:3 densification network) between the Tallinn-Paldiski highway and the planned gas pipeline. Geodetical marks are situated approximately 25–50 m from the planned gas pipeline.

ALT EST 2 natural gas pipeline landfall place includes no existing or planned technical communications.

5.2.9.4 Tourism, cultural heritage and recreational use of the areas

The most important and most attractive natural object, which is under protection, is the Pakri cliff – part the Baltic Klint which starts from the island of Oland and stretches to Lake Ladoga. It has also been nominated as a candidate for the UNESCO list of Cultural and Natural Heritage objects. The klint scarp surrounding Pakri Peninsula is one of the most significant in North Estonia and the entire Baltic klint. The cliff is one of the largest tourist attractions in Paldiski. It surrounds the peninsula from Uuga to Kersalu at a length of 12 km. In the summer of 1999, Harju hiking club opened an international coastal track E-9 section through the Pakri Peninsula. The white-blue-white stripe track is indicated by markings on trees, posts, and stones. The total length of the track is 26 km and it takes about 6–7 hours. The track begins at the Paldiski fortress.

One of the most attractive sections of the Pakri Peninsula and in the whole of North Estonia, is located in close proximity to the ALT EST 2 alternative, and also has a hiking trail at the bottom. There are no statistics on how much tourists use this hiking trail. The main problem in developing tourism in the City of Paldiski is the lack of accommodation and catering facilitiess, and the poor condition of the attractions and tourism objects (*Paldiski Municipality 2013*). The hiking trail is not marked in that area. The hiking trail under the klint is also currently used by all-terrain vehicles.

The ALT EST 2 area is surrounded by an existing potential industrial landscape – in addition to the wind farm, several other production objects are under consideration in the area (developments related to the LNG terminal). Today, access to the section referred to is limited – the territory of Paldiski wind farm is the best way to access it from the roads.

The closest larger beaches are Lohusalu beach on the opposite side of Lahepere Bay (directly approximately 4 km from the ALT EST 2 landfall) and Klooga beach (approximately 2 km from the ALT EST 2 landfall).

According to the comprehensive plan of the City of Paldiski, there are 7 historical and 15 architectural heritage monuments in Paldiski. The most imposing of them all is the Paldiski Peter Fortress (Peetri kindlus). Other important objects include Paldiski Nikolai Church and the Georgi Orthodox Church, cemeteries in the town and on the islands, Pakri lighthouse, etc. According to the comprehensive plan, the list of protected objects needs supplementation, for example, with the defence fortifications from W W I. On the eastern coast of Pakri Peninsula, there is the old Leetse-Lepiku cemetery. One of the most important tourist attractions in the city is the museum of Amandus Adamson, a famous sculptor in Paldiski.

Due to its military background, Pakri Peninsula is not a popular summerhouse region. The comprehensive plan of the City of Paldiski reserves the existing and promising summerhouse regions in the direct proximity of the center of Paldiski (*Entec AS 2004*).

There are no heritage conservation monuments in the areas of the ALT EST 1 landfall point and the mainland section of the gas pipeline up to the compressor station in Kersalu, or in the area of the ALT EST 2 landfall point(see Figure 5-78).

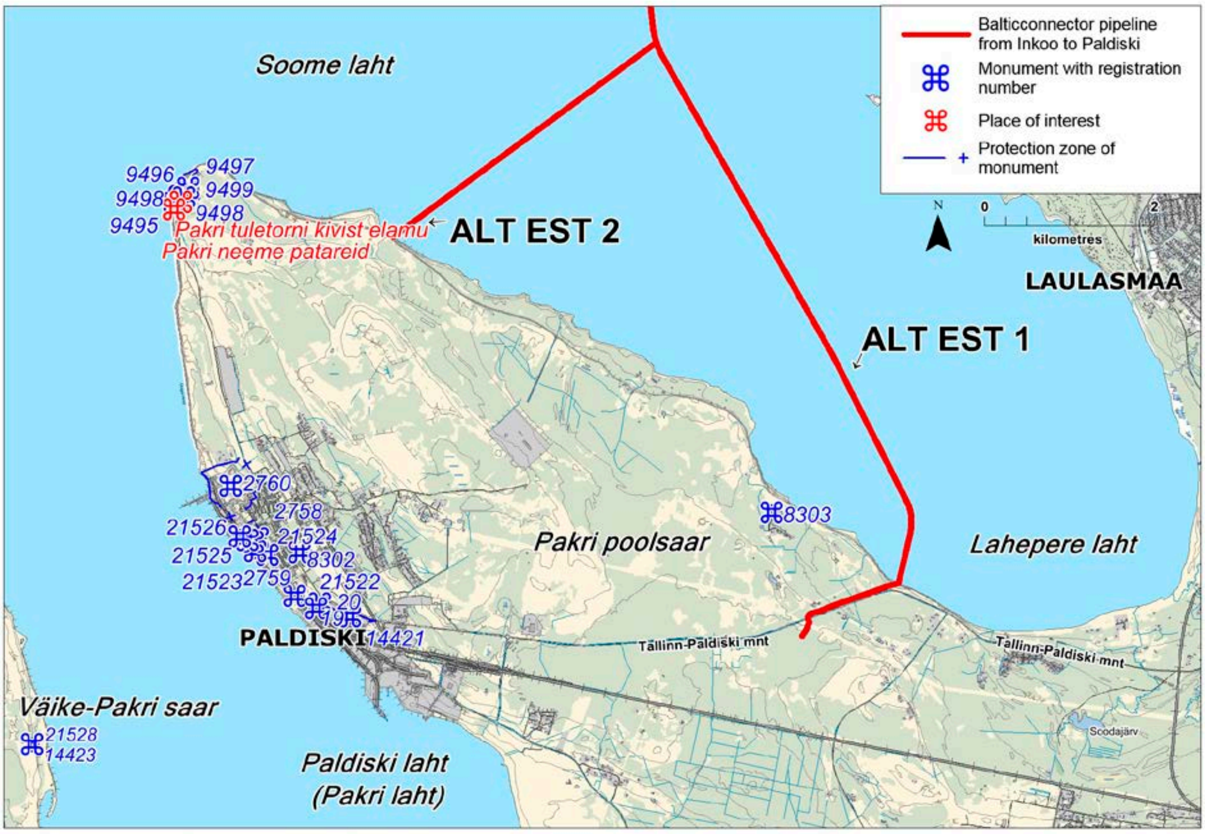


Figure 5-78. Overview of the monuments in the area according to the information from Cultural Heritage Board register.

Although several old farmsteads have not been repopulated since Estonia regained independence, the old land use pattern and village structure with its elements can be observed in the landscape. The most important cultural heritage objects in the ALT EST 1 gas pipeline area in Kersalu and its close proximity are the historic Vana-Tallinn highway and semi-natural communities that have been preserved around the old farmsteads – meadowlands.

Nowadays, the Vana-Tallinn highway is a gravel road, with low everyday traffic intensity. Until the 1960s, the Vana Tallinn highway was the main road to Paldiski and in future, there may be the need to use it again for its original use, but this time for bicycle and pedestrian traffic (*Laansoo 2012, Paldiski Municipality 2013*).

5.2.10 Monitoring stations and areas

An environmental monitoring station or area is a location within the monitoring network where observations and measurements defined by the environmental monitoring program are conducted. Environmental monitoring stations include permanent or temporary environmental monitoring buildings and equipment. There are no permanent environmental monitoring buildings in the environmental monitoring area.

A permanent area of national environmental monitoring is a territory defined for conducting complex long-term national and international environmental monitoring. Topics linked to environmental monitoring are regulated by the Environmental Monitoring Act (*RT I 1999, 10, 154*), which establishes the organization of environmental monitoring, procedures for processing and storing collected data, as well as the relationship between persons conducting environmental monitoring and the owners of immovable property.

Monitoring stations and areas on the Pakri Peninsula, in Lahepere Bay, and in the Gulf of Finland within the Estonian exclusive economic zone in the vicinity of the gas pipeline highlighted in the list included in the Regulation "Establishing national environmental monitoring stations and areas" (*RTL 2003, 96, 1439*).

Table 5-25. Environmental monitoring stations and areas.

Name Code Area (Body of water)	Monitoring	Coordinates				Distance from the pipeline
		Latitude	Longitude	X	Y	
Monitoring stations						
1. Pakri MJ **26029**	Meteorology	59 23 37	24 02 40	6583963	502525	0.4 km from the shore at Pakrineeme in the sea 2 km NW of ALT EST 2 pipeline
Coastal waters monitoring station pe (Western part of the Gulf of Finland)	Overview monitoring of coastal waters, including sea radiation monitoring – seawater monitoring			6582456	508810	At the mouth of Lahepere Bay 300 m SW of ALT EST 1 pipeline towards Leetse Saunakivi
Monitoring areas						
1. 1. Paldiski	Monitoring of the bioindications of heavy metals accumulating from the air in the background area and in the area with great human impact	59 20 36	24 10 56	6578375	510369	200 m SE of ALT EST 1 pipeline at Kersalu
2. Kloogaranna Profile no. 7	Monitoring of the coast	59 20 25	24 12 12			1.2 km SE of ALT EST 1
3. Kersalu Profile no. 4	Monitoring of the coast	59 20 45	24 10 58			100 m NW of ALT EST 1 pipeline
4. Pakri Peninsula	Monitoring of biology on alvars, forests on mineral soil	59 20 40	24 09 30			0.6 km NW of ALT EST 1 pipeline
5. Paldiski Epipactis helleborine - broad-leaved helleborine	Monitoring of endangered and protected vascular plants, species of moss and species under the Habitats Directive					

6 STARTING POINTS OF THE ENVIRONMENTAL IMPACT ASSESSMENT AND THE ENVIRONMENTAL IMPACTS ASSESSED

6.1 Scoping of the assessment

The examined route of the Balticconnector natural gas pipeline will cover the following activities, which have been taken into consideration in the EIA procedure and the environmental impact assessments conducted:

In Estonia

- offshore routing totaling around 81 km in length from Ingå to Paldiski, and;
- landfall alternatives ALT EST 1 and ALT EST 2 as well as an onshore routing of around 1.3 km in length from the Estonian landfall ALT EST 1 to a compressor station planned for Kersalu.

In Finland

- offshore routing totaling around 81 km in length from Ingå to Paldiski; and
- onshore routings totaling around 1 km in length from the Finnish landfalls to the Ingå compressor station; and
- a compressor station in Ingå.

This EIA report does not cover the environmental impacts of the compressor station planned for Kersalu as the assessments concerning it are carried out in conjunction with the permit procedures relating to the project (Estonian project developer). The potential cumulative impacts of the Balticconnector project and the Estonian compressor station and related other activities are described in section 6.11 of this EIA report, while project logistics and related scopings are described in section 3.4.8.

The extent and significance of the environmental impacts are determined depending on the nature of the receptor. Some of the impacts are only aimed at the local environment, while others affect broad national entities. Such national entities typically include the Natura program or the categories of the national land use planning objectives.

In the environmental impact assessment, the environmental impacts of the Balticconnector natural gas pipeline and of the activities arising from the project beyond the pipeline route were examined. Activities beyond the Balticconnector natural gas pipeline route include construction-related vessel traffic in the Gulf of Finland. A brief assessment of the environmental impacts of the decommissioning of the Balticconnector project was also carried out (see section 6.8.2.2).

In this context the observed area means the area determined for each impact type within which the environmental impact in question is studied and assessed. Efforts have been made to make the area determined so large that no significant environmental impacts can be assumed to occur outside the area. The direct impacts extend to the vicinity of the offshore pipeline and onshore activities. As regards the offshore areas of the Gulf of Finland, the descriptions of the current state and the environmental impacts of the project cover the entire Gulf of Finland. As regards coastal and land areas, the main focus of this report in on the Estonian areas, with the most significant assessment findings for the corresponding areas in Finland summarized in Appendix 5 to this report. More detailed descriptions of the impact assessments conducted for the Finnish side can be found in the project EIA report for Finland (*http://www.balticconnector.fi*). The areas observed are described in greater detail specifically for each type of environmental impact.

6.2 Environmental impacts assessed

In this project, the main impacts have been assessed to be impacts caused by constructing the offshore pipeline. Impacts assessed include (offshore and onshore):

- impacts on the seabed and water quality;
- impacts on natural organisms, such as animals, fish and plants;
- impacts on protected areas and values and Natura 2000 sites;
- impacts on ship traffic and boating;
- impacts on land use and land use planning;
- impacts on human living conditions, fishing and safety;
- impacts on landscape and cultural heritage;
- impacts on tourism and recreational use of the areas;
- impacts on utilization of natural resources;
- impacts on air quality;
- noise;

Implementation of the project can cause impacts in the following phases: construction, testing (pumping the pipeline through with water and the mixture of chemicals), operation and decommissioning of the pipeline. In the assessment, direct and indirect impacts have been assessed during construction, operation and decommissioning. Additionally, cumulative impacts of other related projects (i.e. Nord Stream natural gas pipelines, planned LNG terminal in Paldiski and the planned onshore pipeline from Paldiski to Kiili) have been taken into account in the assessment.

EIA report includes a separate section about transboundary impacts (see section 6.11).

The most significant impacts will be caused by the pipeline installation operations, such as dredging, blasting, filling and rock placement to even the seabed under the pipeline structures and prevent freespans. In the operation phase, impacts caused by the project will be quite minor. Impacts of decommissioning have also been assessed (see section 6.8). Current situation in the Gulf of Finland and in the project area is described in the EIA programme and has been supplemented in the EIA report.

Some of the significant impacts are limited to the construction period and some of the impacts are permanent. The nature of each impact regarding time and extent are described in this environmental impact assessment report.

6.3 Studies and assessments carried out for the project

The offshore gas pipeline route has been studied in the following extensive geotechnical, acoustic and environmental studies in 2006, 2013 and 2014:

- Acoustic surveys, remote operated vehicle (ROV) and magnetometric surveys (*MMT 2006 and 2014*);
- Bathymetric survey, for measuring the topography of sea bottom (*MMT 2006 and 2014*);
- Side scan sonar (SSS) survey, to detect seabed features and objects on the seabed (*MMT 2006 and 2014*);
- Sub-bottom profiler, for profiling layers under seabed (*MMT 2006 and 2014*);
- Geotechnical sampling, to achieve more information on geotechnical conditions of the seabed (*MMT 2006 and 2014*);
- Sediment studies and soft bottom macrozoobenthos (*TTU Marine Systems Institute 2013, Ramboll 2014*);
- Benthic flora and fauna on hard bottoms, by scuba diving (*TTU Marine Systems Institute 2013, Alleco Oy 2013*)
- Aquatic fauna, zoobenthos and fish breeding areas around the LNG terminal planned for Ingå, 'Vesikasvillisuus, pohjaeläimistö ja kalojen poikastuotantoalueet Ingåseen suunnitellun LNG-terminaalin ympäristössä' (*Kala- ja vesitutkimus Oy 2014*);
- Fisheries studies (*Ramboll 2013a and Ramboll 2013b*);
- Survey of fish breeding grounds (*University of Tartu 2013*);
- Survey of commercial and professional fishery near shore and offshore (*Ramboll 2013b*);
- Marine mammals study (*Ramboll 2013e*);
- Archaeological surveys (*SubZone Oy 2014 and 2015, Mikroliitti Oy 2014*);
- Nature studies on onshore pipeline areas (*Ympäristösuunnittelu Enviro Oy 2014, Entec Eesti OÜ 2014 and OÜ Tirts &Tigu 2014*);
- Bird surveys (*Estonian Ornithological Society 2013, Ramboll 2013d and Ramboll Finland 2013a*).

6.4 Assessment methods

The following methods have been used to assess environmental impacts:

- analysis of existing data
- studying the results of existing geotechnical and physical studies
- new field studies (surveys) made along the pipeline corridor and around the points of landfall
- consultations with authorities and institutions
- modelling the distribution of environmental impacts
- expert opinions

6.4.1 Assessment of the significance of the impacts

The multi-criteria decision analysis (MCDA) practices and tools developed in the EU LIFE+ IMPERIA project *Imperia 2015* were employed as appropriate in the assessment of the significance of the environmental impacts reported in this EIA report. The components of impact significance as well as overall significance are described in summary tables at the end of each impact assessment section. The significance of impacts is also described in the comparison of the alternatives and the summary of the most significant impacts (section 7.3). The classification criteria for the components of impact significance employed in this project are presented in Appendix 4.

6.4.2 Components of impact significance

For each impact the sensitivity of the target receptor in its baseline state and the magnitude of the change, which would probably affect the target receptor as a result of the proposed project, have been assessed. An overall estimate of the significance of an impact has been derived from these judgments. Both the sensitivity of the target receptor and the magnitude of the change have been evaluated systematically based on more detailed sub-criteria (Figure 6–1).

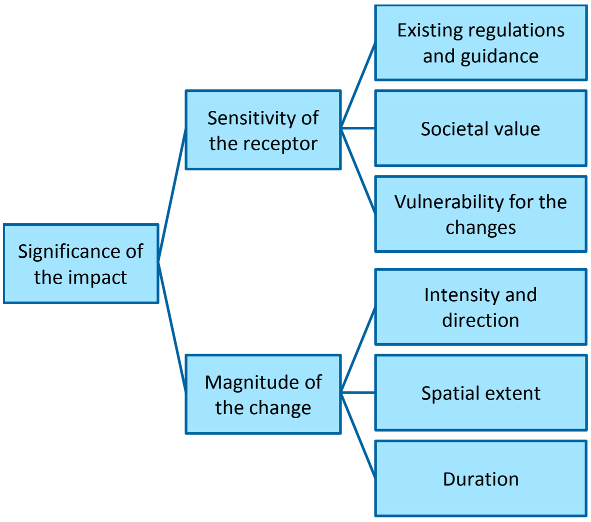


Figure 6–1. Components of impact significance. (*Finnish Environment Institute 2014*)

Sensitivity

Sensitivity of the receptor is a description of the characteristics of the target of an impact. It is a measure of 1) existing regulations and guidance, 2) societal value and 3) vulnerability for the change. The sensitivity of a receptor is estimated in its current state prior to any change implied by the project.

Magnitude

Magnitude of the change describes the characteristics of changes the planned project is likely to cause. The direction of change is either positive or negative. Magnitude is a combination of 1) intensity and direction, 2) spatial extent, and 3) duration. On duration, the timing of the impact should also be considered for impacts which aren't observable all the time such as periodic impacts. Assessment of magnitude should evaluate the probable changes affecting the receptor without taking into account the receptors sensitivity to those changes.

6.4.3 Assessing the significance of an impact

The significance of the impacts was assessed on the basis of the sensitivity of the receptor and the magnitude of change caused by the project. A table (Table 6–1.) where red indicates a negative and green indicates a positive impact was used in the assessments.

Table 6–1. Overall significance of an impact (*Finnish Environment Institute 2014*).

Impact significance		Magnitude of the change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of the receptor	**Low**	High	Moderate	Low	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5 Offshore natural gas pipeline

6.5.1 Impact on the seabed

6.5.1.1 Impact of construction activity

The construction of the Balticconnector pipeline will result in impacts on the seabed of the Gulf of Finland. Depending on the section of seabed and the need for seabed intervention, there will be the need in places to plough (clay bottoms), dredge (harder bottoms) or blast (bedrock) the seabed. Seabed leveling may also take place through rock dumping to create transition sections for freespan rectification.

The most extensive blasting work will be required in the pipeline's landfall zone and the area close to the shore in the exclusive economic zone (EEZ) of Finland where blasting will be needed to lower bedrock peaks by approximately 1.5 m. The final route optimization will involve the avoidance of bedrock, whereby the amount of blasting required is likely to be below the preliminary estimates. Otherwise the pipeline will be laid on clay, whereby ploughing will be the most common method of seabed intervention employed. Blasting may also possibly take place on six sites in the EEZ of Estonia in the context of clearance of wartime munitions unless these can be avoided through route optimization.

Rock blasting and hard-bottom dredging will result in lower levels of suspension of fine fractions in the water column than seabed intervention in clay-rich areas. Clay bottom intervention will result in the suspension of fine fractions up to considerable extents, but even in these cases the impact will reasonably short-term and reversible. Sediment dispersion modelling is covered in section 6.5.2.

The topography of the seabed will be changed in the impact area of the natural gas pipeline, partly due to the above-mentioned seabed interventions and party due to anchoring. In addition, indentations in the seabed will be caused by the clearance of explosive remnants of war. Protrusions from the seabed, on the other hand, will result from rock dumping to protect the pipeline. Depending on seabed material and the construction methods selected, the impacts will be either long-term and permanent or short-term and reversible. Hard-bottom interventions will result in long-term or permanent changes in seabed topography, while soft-bottom interventions will result in short-term and partly or fully reversible changes.

All geological units may face a variety of impacts during pipeline construction. Impacts on bedrock will occur in sections where seabed blasting is required. Other types of intervention will be employed on glacial till and other soil types. It is estimated on the basis of the technical feasibility study and other studies (*MMT 2014)* carried out for the project that seabed blasting and dredging over a section totaling almost 20 km will be required during construction. The largest amount of seabed intervention work will take place on soft bottoms, which is where ploughing will be used. Consequently, the impacts will mainly focus on soft sediments as these are easy to dig or otherwise manipulate, but these may also be changed "involuntarily" due to near-bottom currents caused by construction. Where an anchored pipelaying vessel is used in construction (close to the shore where the use of an unanchored vessel is not possible), the handling of anchors will also result in seabed intervention. In these cases as well the softest sediments will be those the most easily impacted by construction work. Low impacts on the seabed will result from the clearance of wartime munitions.

The section of the pipeline route requiring protection against the impact of ice is between kilometres 7681.4 of the route on the Estonian side. Seabed work necessary for protecting the pipeline is provided in Table 3-3 in the sections of the route. Seabed work required to establish an adequate foundation for the pipe is provided in Table 3-4. Trenching will occur in the kilometres 0–23 (25 000 m); 3739 (2 000 m); 44–46 (2 000 m); 76–81.4 (5 400 m) of the route. There are no significant differences between alternatives. ALT EST 1 burdens the seabed in the length of approximately seven kilometres when ALT EST 2 burdens the seabed in the length of approximately four kilometres.

6.5.1.2 Impact of operation and maintenance

The Balticconnector natural gas pipeline will cover a strip of the seabed in the Gulf of Finland. The pipeline and the subsea rock installations protecting it will in many places create a protrusion from the seabed, which will have some impact on local near-bottom flows of water. This may result in slight changes in erosion and accumulation conditions in the immediate vicinity of the pipeline. Impacts on the seabed may occur more intensively in the zone of impact of waves (1/2 of wave length) and they may not occur at greater depths. There will be no impact if the pipeline does not influence the movement of water or if the pipeline is constructed further away from the zone of impact of waves using a tunnel.

The friction in the pipeline caused by the flow of compressed gas may result in a rise in the temperature of the pipeline amounting to a few degrees. This will impact the seabed sediment at a maximum radius of a few meters from the gas pipeline. This change in temperature will not play any practical role as regards sediment characteristics. Pipeline stability and durability will be monitored throughout its operational life and whenever necessary, including due to erosion caused by currents, the stability of the pipeline will be ensured through maintenance measures. Pipeline maintenance measures will include the addition of soil around the pipeline wherever necessary. Such measures may contribute toward changes in near-bottom flows, whereby changes in flows may cause changes in erosion or sediment accumulation in nearby areas. The cumulative impacts of the resuspension of sediments caused by soil addition for maintenance reasons and any increase in net sedimentation caused by flow changes are, however, estimated to be low.

Summary of the significance of impacts

The seabed's vulnerability to change due to the project is low. Soft-bottom seabed interventions will be short-term and in part or fully reversible. Any permanent changes in hard bottoms will be low in terms of significance. The magnitude of the change is expressed by the surface area of the horizontally impacted region and the thickness of the removed sediments. The change will not cause the limit values to be exceeded, and the quantity/burden of emissions will not increase. Changes resulting from the project will be insignificant in the offshore part. The change to the status of the region caused by the project will be minor. The impact will be low negative.

Table 6-2 Impact significance on the seabed. C = construction phase, O = operation and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	Moderate	**C & O Low**	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.2 Impact on hydrology and water quality

The dispersal and deposition of suspended matter along the planned Balticconnector pipeline route in different meteorological conditions during the construction activities requiring seabed intervention have been analyzed.

The following activities were considered:

- seabed intervention due to gravel dumping (pre-lay phase);
- seabed intervention due to blasting (blasting);
- seabed intervention during dredging (dredging operations);
- gravel dumping to stabilize and cover (where needed) the pipeline (post-lay phase).

In order to assess sediment transportation along the planned pipeline route in Estonian waters, the hydrodynamic model High Resolution Operational Model for the Baltic Sea (HIROMB) as well as the Lagrangian algorithm describing particle movement were used. As shown by a comparison of currents obtained from the model and in-situ measurements, the model simulates very well the statistical distributions of current velocity parameters. The only difference noticed is a slight underestimation of current speed by the model in the near seabed layer of the deep area. Various sedimentation rates have been applied to the particles, depending on particle size. Table 6-3 lists sedimentation rates used in modeling based on material type (sediment particle size).

Table 6-3. Material types used in modeling, as well as their particle size and sedimentation rate.

Sediment type	Size [mm]	Sedimentation rate [m/day]
Clay	< 0,002	0.5
Fine silt	0,002-0,01	1.5
Silt	0,01-0,063	6
Sand	0,063-2,0	16.8
Gravel	> 2,0	249

The highest sedimentation rate used in the calculations was 249 m/day and the lowest 0.5 m/day.

Preliminary phase (pre-lay)

During the preliminary phase of pipeline installation it is planned to level the topography of the seabed by dumping gravel onto it. Material amounts used in model calculations are specified in the pre-FEED report (*Ramboll 2014a*), which was obtained using a description of planned work. It was assumed that the amount of sediment released into the water column would be 2% of the amount of gravel used.

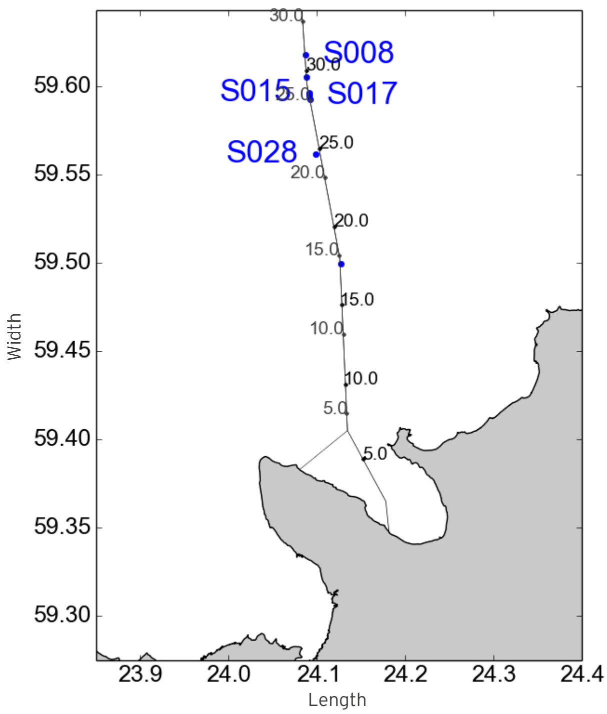


Figure 6-2. Work locations in the pre-lay phase corresponding to the sediment transportation simulated in the model calculations.

Material of larger particle size will settle fast in the immediate vicinity of the site, and therefore Figures 6-2 and 6-3 illustrate the amounts of suspended matter consisting mostly of fine particles (clay) at two different work sites at 0.5, 2.0 and 5.0 days after seabed intervention in three characteristic meteorological conditions. In the case of the site S08, the amount of gravel used is about 1,000 m³, and the concentration of suspended sediments (integrated for the 5 m near-bottom layer) is below 10 g/m² over the whole area after 0.5 days. In the case of the site S15 (close to the previous site, but the amount of gravel is 3 times larger), higher concentrations are observed for a longer time and the integrated amount of suspended matter over 10 g/m² extends further than 1 km from the work site. It is interesting to note that sedimentation is slower in calm conditions and fastest in conditions of a strong northwesterly wind.

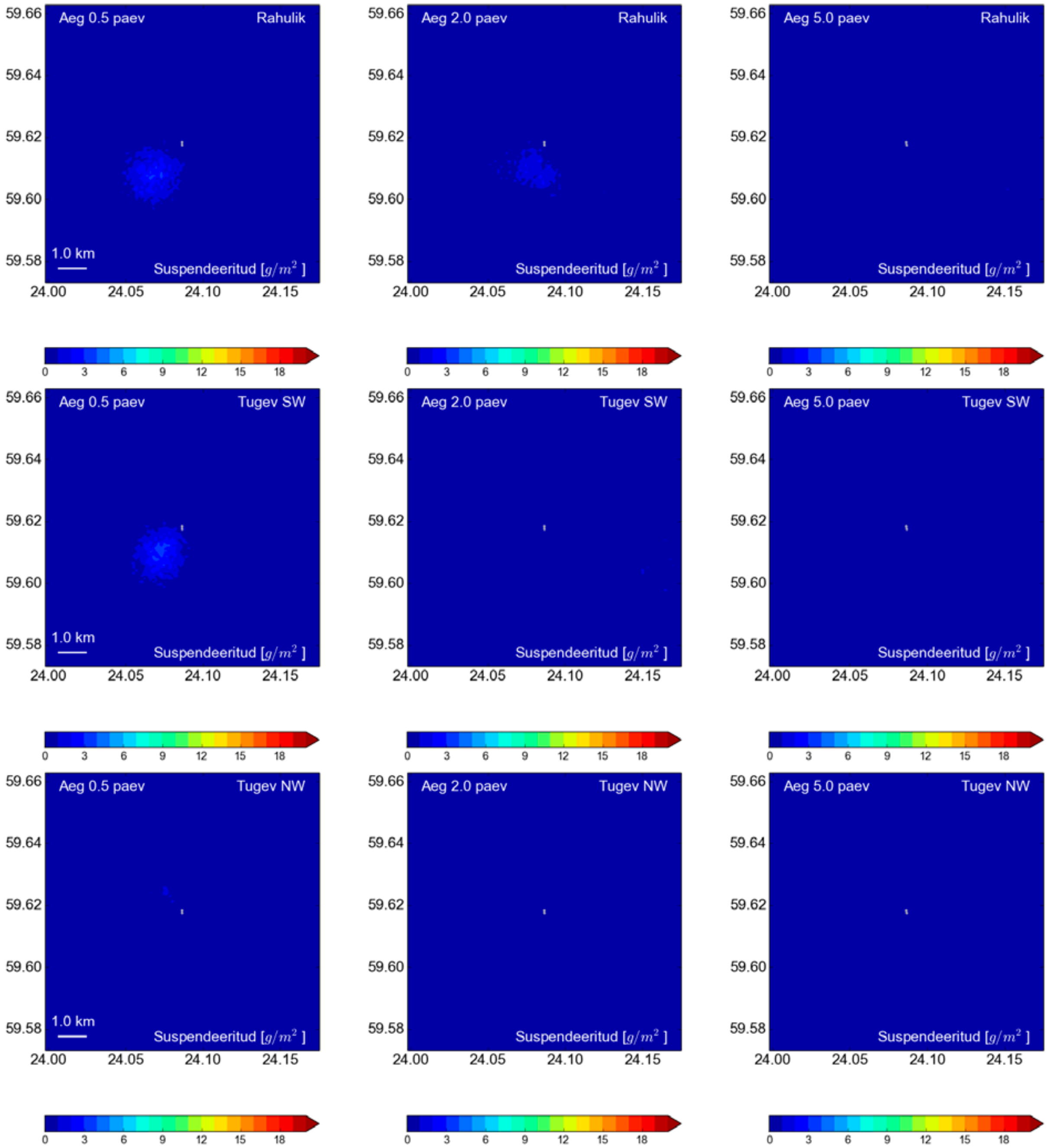


Figure 6-3. Amount of suspended matter in the case of particles lifted up into the water column to 5 m from the seabed in calm conditions (upper panel), strong SW (middle panel) and strong NW (bottom panel) winds due to seabed interventions during the pre-lay phase at site S008 (at 0.5, 2.0 and 5.0 days).

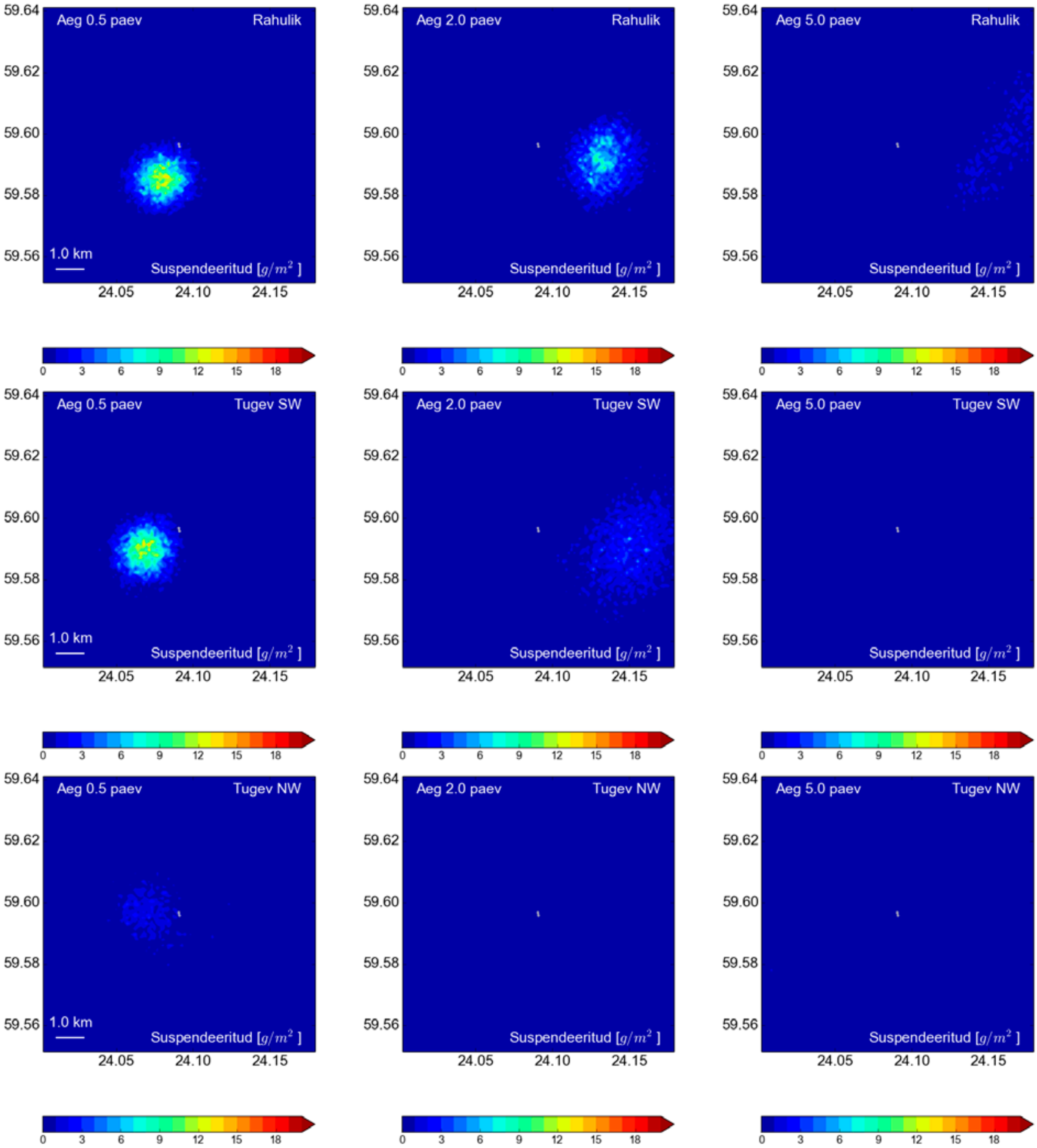


Figure 6-4. Same as Figure 6-3 intervention work at site S015.

Blasting

Potential locations of blasting sites are specified in section 3.4.

Since at the time of conducting this study, the extent of planned blasting procedures had not yet been finally decided, it is not possible to accurately assess the amount of sediments lifted into the water column, including estimating the exact height from the seabed where the sediment would be raised. In the model experiments, it wasassumed that the material would be lifted to a height of up to 5 m from the seabed. The dispersion of suspended matter in Figures 5–6 and 5-7 is given as a percentage of the initial amount of sediments (in concentration units) lifted into the water column. As seen from the results, the concentrations of suspended matter are higher within a patch of a spatial scale of about 1 km, but the patch can be transported from the initial position in a south-westerly (site 41) or north-easterly (site 47) direction for about 2–3 km from the initial position. Turbidity decreases faster in the case of stronger winds, which can be explained by more intense mixing since the currents in the near-bottom layer are also stronger in such cases (*TTÜ Mereuuringute Instituut 2014 and TÜ EMI 2011*).

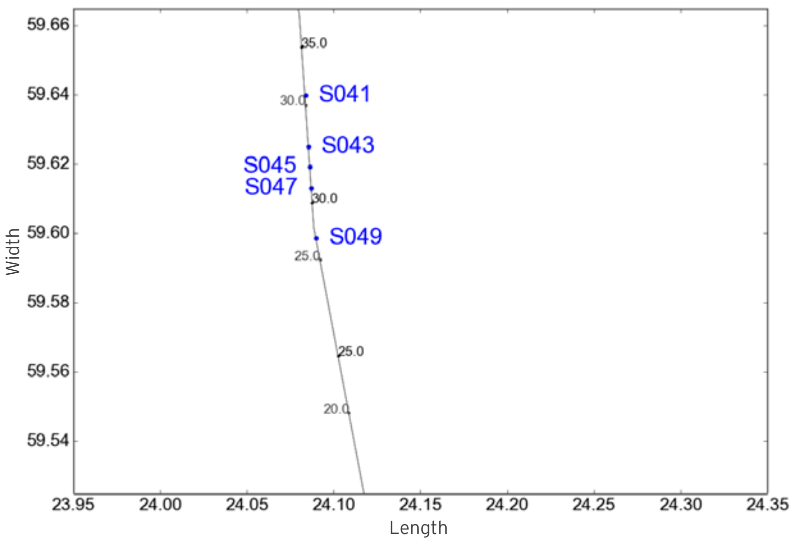


Figure 6–5. Potential locations of blasting sites used in the model calculations.

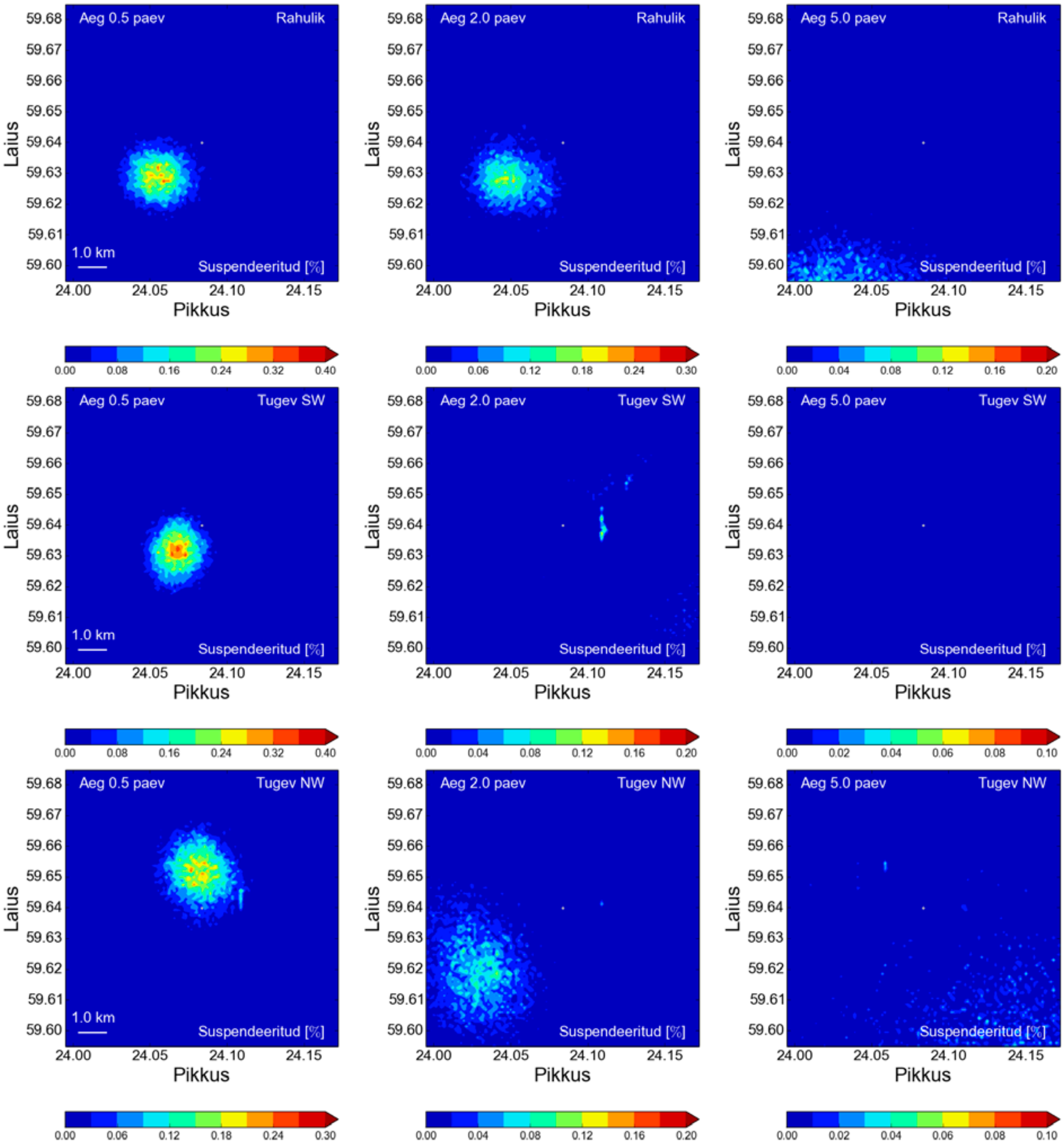


Figure 6-6. Relative amount of suspended matter in the case of particles lifted up into the water column to 5 m from the seabed in calm conditions (upper panel), strong SW (middle panel) and strong NW (bottom panel) winds due to a blast at site S041 (at 0.5, 2.0 and 5.0 days). The color scale differs for different model experiments and time periods.

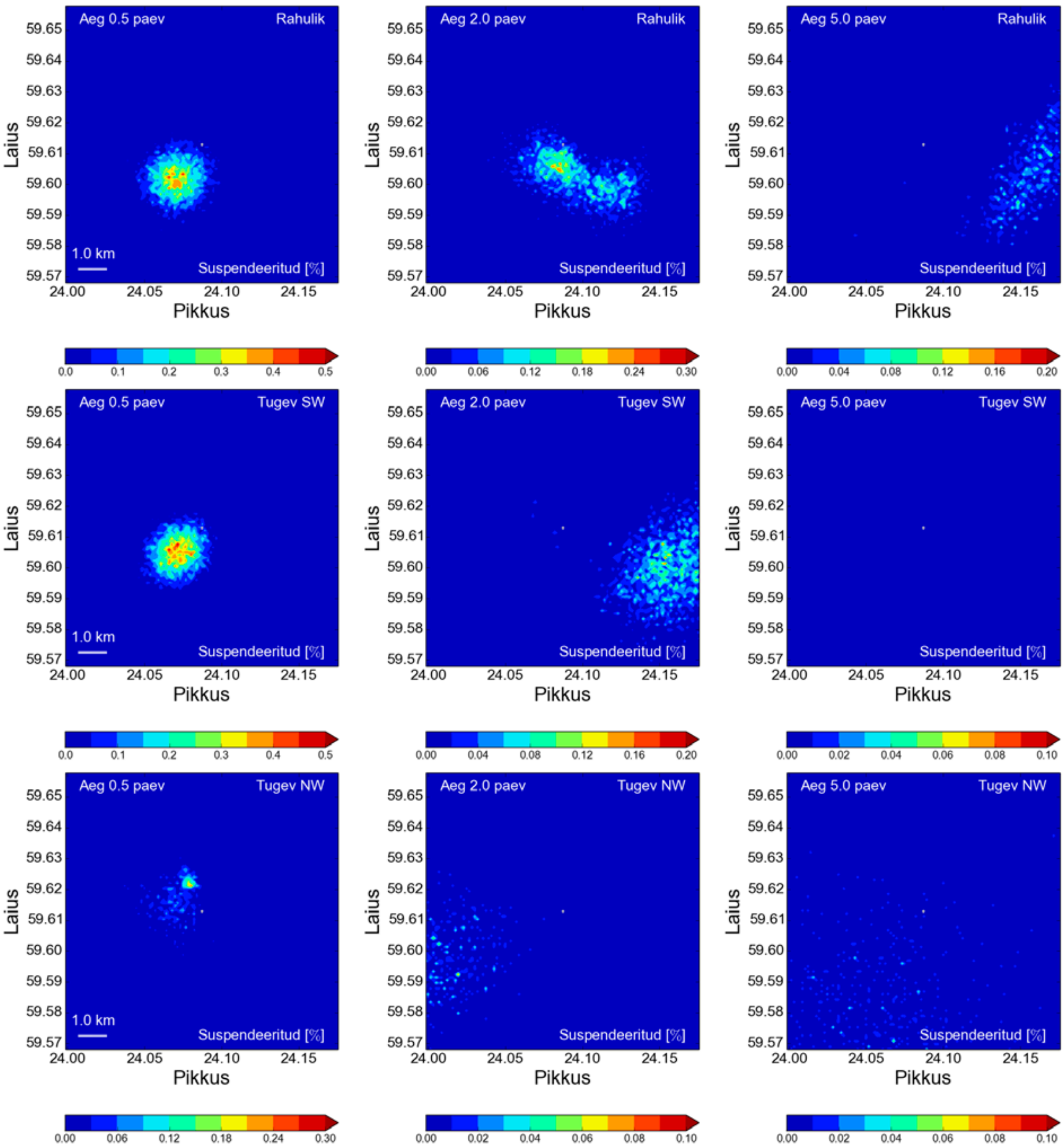


Figure 6-7. Relative amount of suspended matter in the case of particles lifted up into the water column to 5 m from the seabed in calm conditions (upper panel), strong SW (middle panel) and strong NW (bottom panel) winds due to a blast at site S047 (at 0.5, 2.0 and 5.0 days). The color scale differs for different model experiments and time periods.

Dredging

Sediment dispersal due to possible dredging / trenching was assessed for both alternatives under consideration. The extent of dredging is based on conservative calculations (*Ramboll 2014a*).

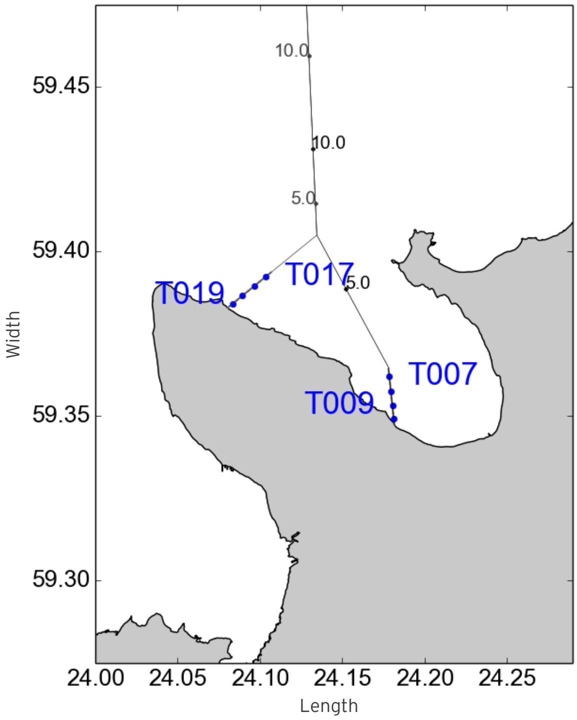


Figure 6-8. Potential locations of dredging sites used in the model calculations.

Dredging/trenching is planned in the Estonian waters in Lahepere Bay in the case of both alternatives. Since the sediments consist mostly of coarse material, sedimentation of suspended matter is fast in the vicinity of the working sites. From a single working site, the area with suspended matter > 10 g/m2 (integrated over a 5 m thick near-bottom layer) extends no further than 2 km.

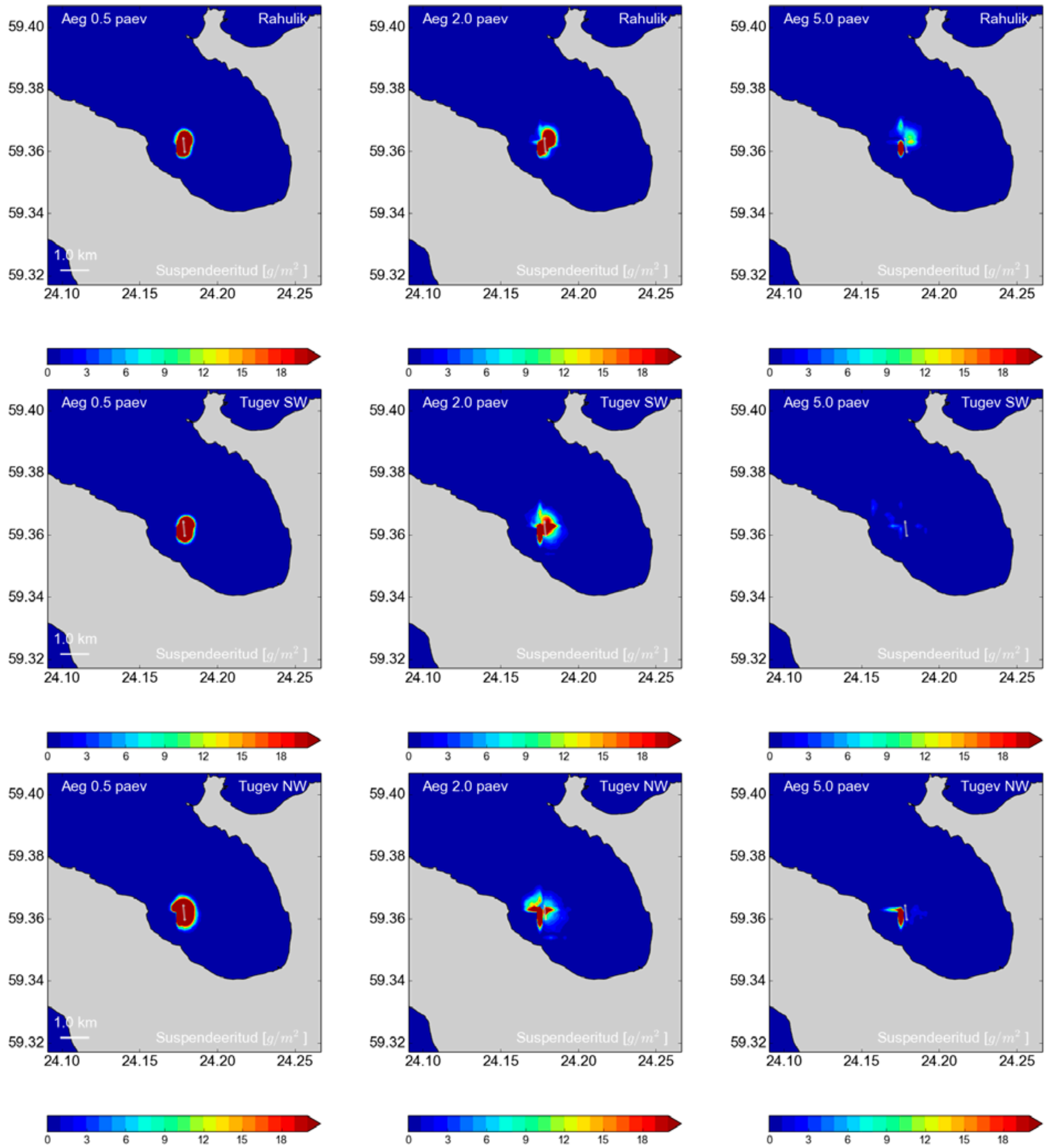


Figure 6-9. Amount of suspended matter in the case of particles lifted up into the water column to 5 m from the seabed in calm conditions (upper panel), strong SW (middle panel) and strong NW (bottom panel) winds due to dredging at site T007 (ALT EST 1 at 0.5, 2.0 and 5.0 days).

Post-lay

Post-lay operations include covering the pipeline with gravel. Planned amounts are specified in section 3.4.

The total amount of gravel used during the post-lay is much higher than during the pre-lay phase. However, the amount of gravel along a certain section of the pipeline is approximately the same. The characteristics of sediment dispersion are thus comparable to the results of pre-lay simulations (see Figures 5-3 and 5-4). An example of suspended matter distributions in Lahepere Bay is shown in Figure 5-11. The result is similar to that for dredging/trenching – the maximum extent of the area with suspended matter concentration > 10 g/m² is about 1–2 km.

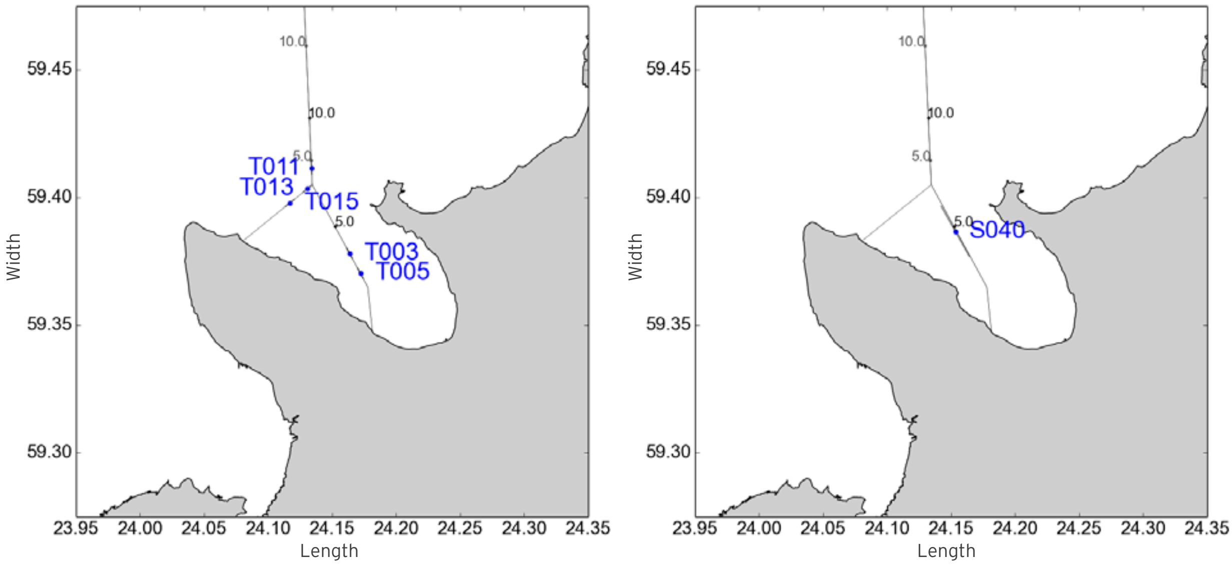


Figure 6-10. Possible locations of post-lay used in the model calculations. Modeling was conducted for both ALT EST 1 and ALT EST 2.

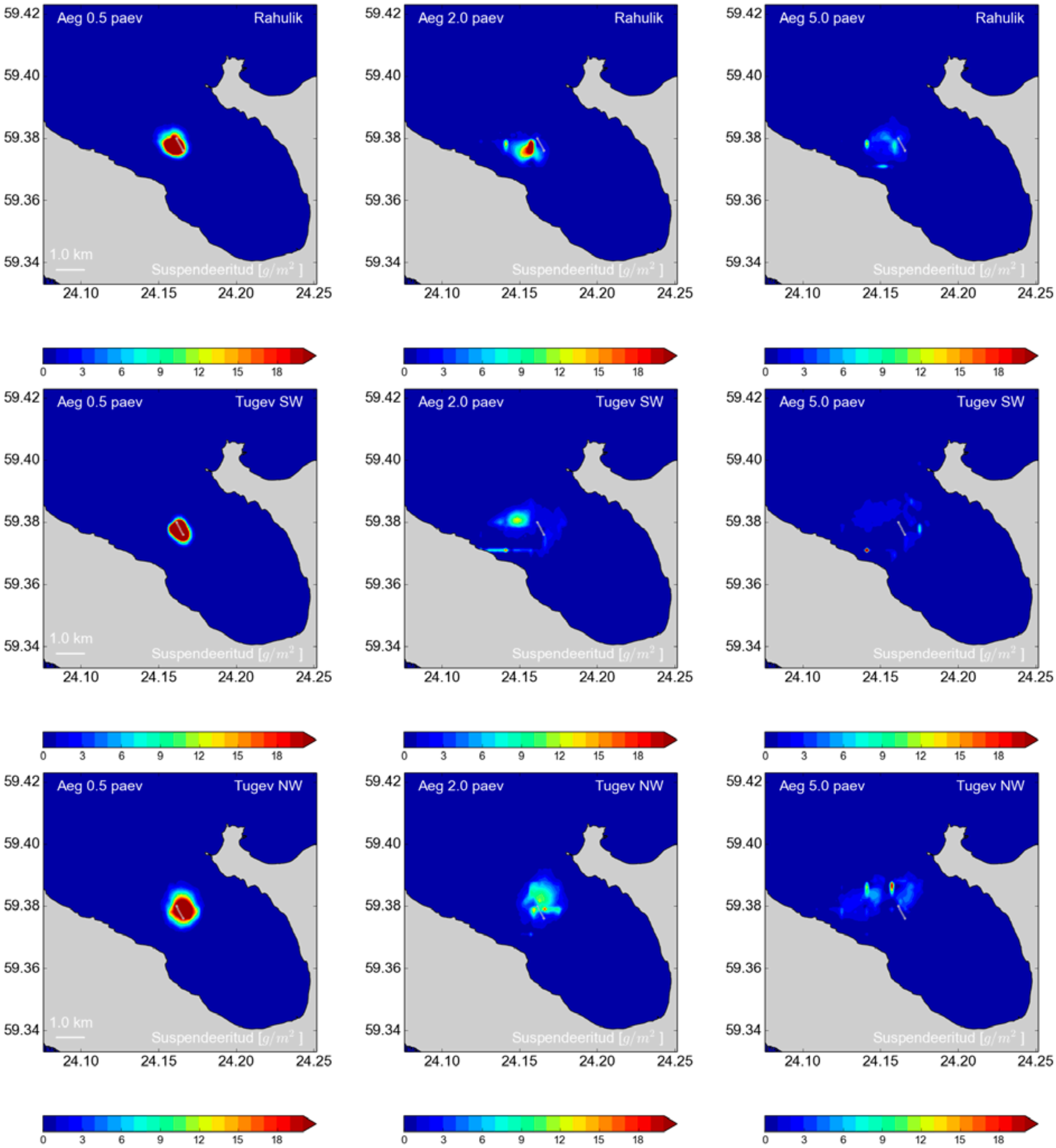


Figure 6–11. Amount of suspended matter in the case of particles lifted up into the water column to 5 m from the seabed in calm conditions (upper panel), strong SW (middle panel) and strong NW (bottom panel) winds due to dredging at site T003 (at 0.5, 2.0 and 5.0 days).

6.5.2.1 Impact of construction activity

Dispersal and deposition of re-suspended particles

Sediment transportation model calculations in relation to different activities along the pipeline route were conducted in order to assess the impact of the construction of the Balticconnector gas pipeline on water quality. Factors taken into account include the extent and locations of planned seabed intervention work, as well as the character of sediment along the route. Model calculations are conducted for different characteristic meteorological conditions – weak winds, strong southwesterly winds, and strong northwesterly winds. The aim is to define the extent to which re-suspended particles dispersed during different construction activities in weak and strong winds, and to assess the significance of the impact/ significant impacts– i.e. assess the areas of decreased visibility in the water caused by seabed interventions, and assess the extent of the area where larger amounts of sediments released to the water column would be deposited.

Dispersion of re-suspended particles in the open part of the Gulf of Finland (outside Lahepere Bay) in the case of weak winds is mostly characterized by transportation along the gulf (in the deep layer along the deeper part of the gulf), and along the slope towards the northeast (east). This flow can be intensified or reversed due to winds. The characteristic SW-NE-oriented cloud of re-suspended particles 45 days after, for example, the beginning of the work period is seen in Figures 64 and 67 (pre-lay phase works and blasting). In the case of strong winds, the sediment would disperse further, but the diffusion of floating material is significantly higher, and therefore the decrease in water transparency near the work site would be highly limited in time (turbidity decreases faster).

The dispersion pattern of suspended matter in Lahepere Bay, where the main tasks generating resuspended particles include dredging/trenching and/or digging the pipe into the soil, differs to that of the open sea. The cloud of re-suspended particles will mostly be limited to the bay, especially so in case of ALT EST 1, which includes work in the inner part of the bay. As a result of dredging conducted in the inner part of the bay, the re-suspended particles would probably disperse toward the Pakri Peninsula, but if post-lay operations are conducted in the central part of the bay, the particles would disperse toward Pakri as well as the Ihasalu Peninsula). It is important to note that the concentrations of suspended matter shown in the figures away from the work area (2–5 days after work) are very low. Most of the sediments released into the water column will be deposited in the immediate vicinity of the work area (within 1–2 km).

Model experiments are based on the assumption that initial water turbidity is 0. In order to define the impact of the dispersion of re-suspended particles, a limit value of 10 g/m³ is used, as this is usually considered in Estonia as a limit value for turbid waters, although the corresponding legally binding limit has yet to be defined. The area of suspended matter concentration > 10 g/m³ (by analysing all defined work types and amounts, as well as weak and strong wind conditions) extends up to 3 km from the work area. The impacted area is larger in relation to the seabed intervention work in the deep part of the pipeline route, where fine sediments prevail. In Lahepere Bay, where mostly coarse sediments exist, the impacted area is less at about 2 km. However, lower concentrations of suspended matter up to 1 g/m³ can be found close to the shores of the bay as well, especially near the Pakri Peninsula.

Since the installation work is conducted during different periods (relatively long periods), the amount of suspended matter released into the water column during different operations will not be cumulated –water turbidity will not increase as a sum of the impacts from all work. However, when work is carried out continuously, some increase in concentrations of the suspended matter will exist in comparison with the present calculations. In order to assess the combined effects of all construction activities, the total amount of material deposited over the adjacent sea areas needs to be estimated, as it is done and described below.

Sediment load (g/m²) assessments in different meteorological conditions are specified in Figure 6–12 to Figure 6–14. With weak winds and strong SW winds, the sediment loads resulting from pre-lay operations are similar. The highest loads are recorded for work conducted in the middle of the Gulf of Finland in the deepest area in calm conditions. An area with a certain load will also extend further from the pipeline in the deeper area in the middle of the gulf. With strong northwesterly winds, the loads and their extent are smaller in the deeper areas. This is probably because transportation is headed away from the working area (towards the deeper area) – the sediment is dispersed more evenly across a larger area, but loads are smaller than in calm conditions.

Trenching/dredging is planned to be conducted in shallow areas in Lahepere Bay. The amount of material released into the water column as a result of these operations is estimated in section 3.4. Since most of sediments in this area consist of more coarse material, particles will settle relatively rapidly. Although the results of modeling of the spreading of re-suspended particles indicated that suspended matter can be dispersed quite far toward both shorelines in the bay, most of the material would settle in the immediate vicinity of the work area. A certain amount of sediment can be transported and settle outside Lahepere Bay toward the open sea from the tip of Ihasalu Peninsula only in Alternative 2 in the case of strong NW winds (Figure 6–13). In this case, extent of sediment dispersion is the largest.

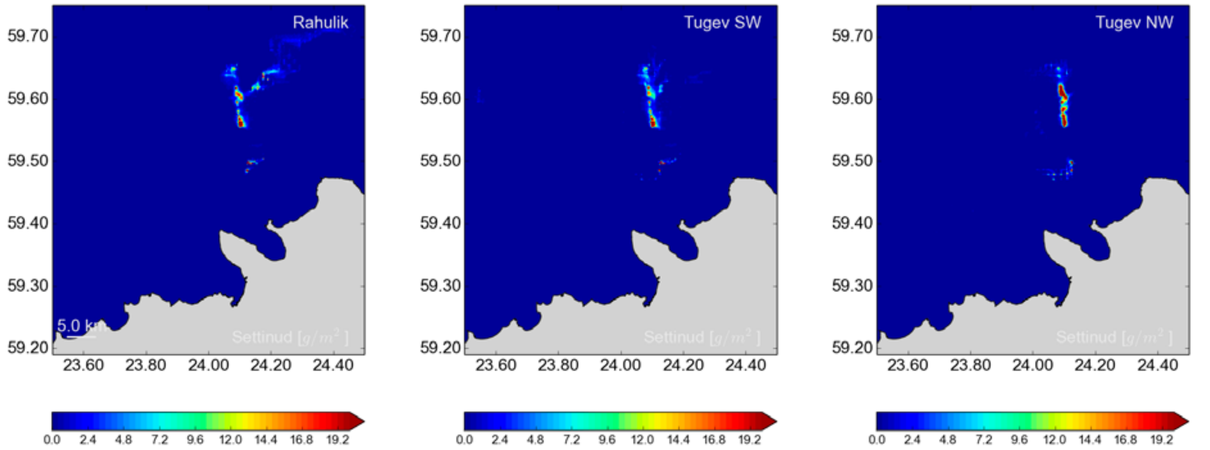


Figure 6–12. Total sediment load (g/m²) from the planned pre-lay and post-lay activities in different meteorological conditions.

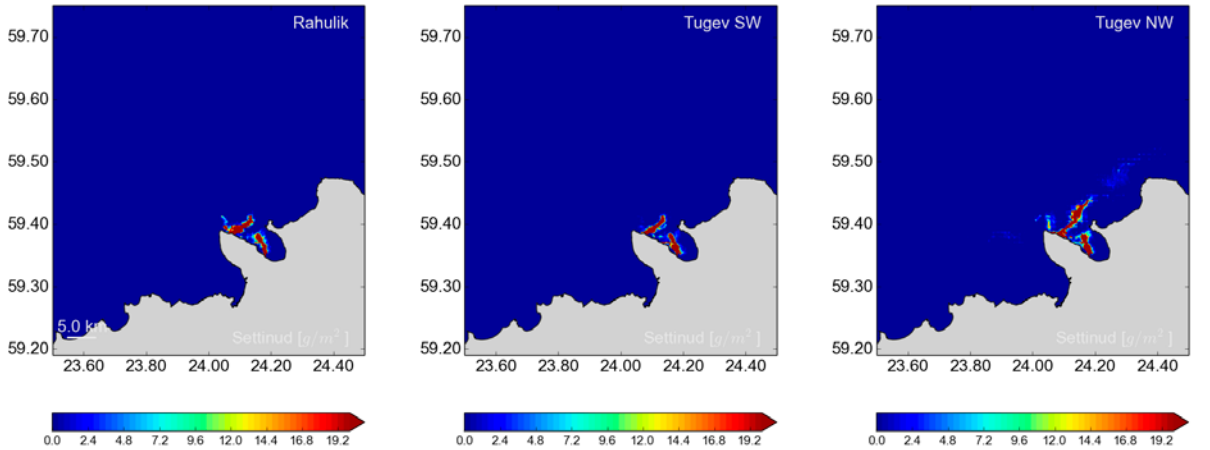


Figure 6–13. Total sediment load (g/m2) from the planned dredging activities in different meteorological conditions.

A sediment load value of 10 g/m² has been used for assessing the impact of sediment transportation (dispersion and settling). Estimated maximum distances for the extent of area with the load of 10 g/m² for different activities are the following: for pre-lay and post-lay gravel dumping, mostly up to 3 km, but in the deep area in certain conditions and in the mouth of Lahepere Bay in the conditions of strong W-NW winds up to 5.9 km; for dredging/trenching in Lahepere Bay, mostly between 2–3 km, However, in the mouth area for ALT EST 2 works up to 7.0 km.

Water quality

Findings from continuous measurement at control stations carried out in conjunction with monitoring conducted for the Nord Stream gas pipeline project show mostly minor near-bottom turbidity, but strong flows were detected in near-bottom water in the context of stormy weather, coupled with rapid increases in turbidity, with the highest turbidity value being 23 NTU at control station 1 (Figure 6–14). Nord Stream control station 1 is located in western Gulf of Finland in the Ekenäs archipelago at a depth of 43 m. Construction work did not impact water quality at the control stations, and the measurement results have been used as background data for monitoring the impacts of the project's construction work.

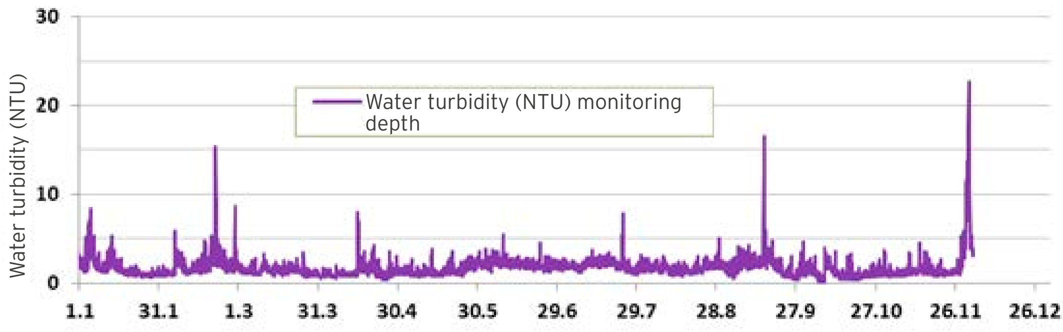


Figure 6-14. Seawater turbidity at 1 m from the seabed in continuous measurement at a western Gulf of Finland control station of the Nord Stream gas pipeline project in 2012. *(Luode Consulting Oy 2013)*

The impact of seabed intervention work on water quality refers to a decrease in water transparency as well as release of harmful substances and nutrients (mostly phosphorus) from the sediments. Based on the study on distribution of harmful substances along the planned pipeline in Estonian territorial waters and exclusive economic zone (EEZ), the concentration of harmful substances in the upper 20 cm layer of sediment is relatively low (*TTÜ Eesti Meresüsteemide Instituut 2013*). As regards heavy metals, the concentration of mercury in sediments was below the detection limit (0.1 mg/kg) in all samples, maximum concentration of cadmium was 0.88 mg/kg, lead 38 mg/kg, nickel 58 mg/kg, arsenic 12 mg/kg, cobalt 24 mg/kg, chrome 96 mg/kg, copper 56 mg/kg, and zinc 170 mg/kg. All the maximum values referred to above were measured at the deeper stations in the open part of the Gulf of Finland, which are sediment accumulation areas. Sediment analysis conducted in 2011 during the Nord Stream impact study along the Gulf of Finland produced similar results (*TTÜ Eesti Meresüsteemide Instituut; TÜ Eesti Mereinstituut 2011*). For example, the concentration of cadmium at the closest station to the Balticconnector work area (samples from the upper 5 cm layer) was below 0.4 g/kg, concentration of copper up to 40 mg/kg, lead 43 mg/kg, zinc 178 mg/kg, and mercury 0.07 mg/kg. Concentration of dioxins was also similar to values found during earlier studies in the western part of the Gulf of Finland – the maximum value was 0.005 ng/g I-TEQ.

At the accumulation area (deepest area along the planned pipeline route), the sediments were analyzed for concentrations of harmful substances also in the 20–40 cm layer (*TTÜ Eesti Meresüsteemide Instituut 2013*). All analyzed substances had lower concentrations in the 20–40 cm layer than those in the 0–20 cm layer. Thus, if seabed intervention work in the accumulation area re-suspends deeper sediments, the impact would be no higher than the impact from the re-suspended surface sediments.

It is difficult to quantitatively assess the amount of harmful substances released from the sediments into the water column as a result of seabed intervention work. It is also difficult to assess the amount of released substances entering the food chain and accumulating in organisms. The construction of the Balticconnector pipeline can qualitatively be compared to a previous significantly larger gas pipeline consisting of two gas pipes in the Baltic Sea – that of the Nord Stream gas pipelines. For Nord Stream, the amount of gravel used in the Gulf of Finland during pre-lay and post-lay operations exceeded 1.6 million m³ (1.3 million m³ in Russian waters and 300,000 m³ in Finnish waters; Nord Stream, 2009). During the construction of the Balticconnector pipeline, it is planned to use a total of 990,000 m³ of gravel on the seabed during preparation and post-operation. tot This is comparable to that used in the Nord Stream project in the Gulf of Finland. According to the present design and estimates in Estonian waters, 320,346 m³ gravel will be used (total of pre-lay and post-lay operations) and the amount of dredged material will be 5,400 m³ in Lahepere Bay and 2,000 m³ at the EEZ border.

A significant difference with regard to potential impact of harmful substances (organostannic compounds, dioxins and radionuclide) derives from the fact that the Nord Stream pipeline was constructed along a deeper area (accumulation area) of the Gulf of Finland, and the concentrations of harmful substances there are higher than on the slopes of the gulf and in the shallow areas (not accumulation areas). Therefore, the impact of harmful substances released into the water column during the construction of the Balticconnector pipeline will be lower. However, considering the planned pre-lay and post-lay operations e.g. for leveling the seabed and protecting the pipeline in areas of high vessel traffic and in coastal waters, the construction work will definitely have a certain impact on the ecological system of the Gulf of Finland.

In Estonia, no regulation concerning the limit values of contaminants in the aquatic sediments is yet available. Usually Regulation No 38, August 11, 2010 of the Ministry of the Environment is applied (*RT 1 2010,* *57, 373*). Under this regulation, all concentrations of contaminants in the sediments collected in 2013 along the planned pipeline in the Estonian territorial waters and EEZ were below the target values, except for nickel at 2 sampling points and for cobalt at 1 sampling point (*Lips 2013*) – but the values were well below the limit values for the living zone; thus, the sediments were considered non polluted.

The amount of harmful substances raised into the water column can be estimated taking into account the above-statedamounts of gravel used (an estimated 2% of this amount of sediments will be lifted into the water column), material dredged and the concentration of contaminants in the sediments. A total of around 12,800 m³ of sediments will be lifted into the water column in Estonian waters. Assuming the dry weight of the sediments is 700 kg/m³, this results in 8.96 thousand tonnes of dry material. According to this, the estimated total amount of contaminants which will be moved is: 784 kg of Zn, 302 kg of Cu, 450 kg of Cr, 111 kg of Co, 69 kg of As, 278 kg of Ni, and 148 kg of Pb. For Cd and Hg, it is difficult to assess the amount of metals raised with the sediments into the water since the results of the analyses were mostly below the detection limit.

In comparison with the total load in the Gulf of Finland, the amounts of contaminants lifted with the sediments into the water column are very low. However, in a limited area, this could give rise to concentrations of harmful substances in the water above the defined limit values. In Estonia, the concentrations of dissolved metals in the water are defined by the Regulation No 49, September 9, 2001 of the Ministry of the Environment (*RT 1, 04.08.2011, 4*). Assuming that all metals in the suspended sediments will be released into the water (as soluble compounds) then, for instance, the concentration of Zn will be above the limit value already when suspended matter concentration in the water is about 100 g/m³ (this appears close to the working sites). However, since the release of contaminants depends on background conditions, e.g. on oxygen conditions, the outcome of the construction work will also depend heavily on those parameters. It can be concluded that the construction work will have a minor impact on the concentrations of contaminants in the water of the Gulf of Finland, but this conclusion has to be checked by monitoring during the construction work.

The concentrations of phosphorus in the upper 20 cm layer along the pipeline route differed between 610 and 1 300 g/kg (per dry weight of sediments). The relationship between the total phosphorus concentration in the sediments of coastal waters and mobile phosphorus content can be expressed using the regression line formula y = 0,0036*x – 3,4264 (*Malmaeus 2012*), where y is the content of mobile phosphorus in the uppermost sediment layer g/m² and x is the total phosphorus content in the sediment. Based on this formula, the mobile phosphorus content in the sediment of the gas pipeline route would be a maximum of 1.2 g/m², which can potentially be released from the sediment as a result of intervention works.

During the pre-lay and post-lay operations, a total of 320,346 m³ of gravel will be used to level the seabed and protect the pipeline in Estonian waters. Assuming that the total area that will be influenced is about 320,000 m² (if the average thickness of the layer is 1 m), the maximum amount of phosphorus released as a result would be 384 kg. The estimate obtained is very small when compared to phosphorus loads from land to the Gulf of Finland (approximately 6,500 tonnes per year of total phosphorus in 2008–2010 (*HELCOM 2013*) and phosphorus released from the sediments in anoxic conditions.

Another way to estimate the release of phosphorus is to take into account the concentration of phosphorus in the sediments, and the total amount of sediments lifted into the water column. The impact of seabed intervention work would thus be the decrease of N/P ratio at least locally and temporarily that in turn could favor growth of cyanobacteria. Using this approach, the total amount of phosphorus moved with the sediments in the Estonian waters will be about 7.0 tonnes. However, how much of it will be released into the water as dissolved compounds, depends on background conditions, especially on the oxygen conditions in the near-bottom layer. Thus, an impact exists locally, but the total phosphorus load from the seabed intervention works is as a maximum about 1.2% of the total monthly phosphorus load into the Gulf of Finland. In conclusion, the impact is minor, temporary and local, but to confirm this, the impact must be monitored during the construction period.

Pipeline cleaning and marine impacts of flooding

Following the pressure test, the seawater used to flood the pipeline will be filtered and treated with oxygen scavengers (e.g. sodium bisulfite, $NaHSO_3$) and/or biocides (e.g. glutaraldehyde). Oxygen scavengers remove oxygen that may fuel corrosion, and biocides prevent the growth of anaerobic bacteria. A typical dosage of sodium bisulfite is 65 mg/l (ppm) being required for an oxygen concentration of 10 ppm and for glutaraldehyde 50–75 mg/l (ppm). Alternatively, sodium hydroxide (lye) can be used as a biocide, enabling the increase of water pH above 10 and therefore preventing the growth of anaerobic bacteria in the pipeline. The use of sodium hydroxide may, however, cause other technical problems in the pipeline relating to carbonate and hydroxide precipitate formation. The pipeline pressure test takes around 24 hours, while the total maximum treatment period is 60 days. Flooding can also be carried out using clean water without any additives.

Sodium bisulfite and sodium hydroxide are natural substances already present in seawater, and the treatment poses no risk to the marine environment.

Glutaraldehyde is rapidly biodegradable but highly toxic to aquatic organisms, whereby special care must be taken in its dosage. According to the OECD SIDS (Screening Information Data Set) report published by UNEP, the glutaraldehyden PNEC (predicted no-effect concentration) values are 21 µg/l for water organisms and 9 µg/l for algae. The PNEC values are clearlylower than the actual NOEC (no observed effect concentration) values measured. (*OECD SIDS 2001*)

The impact and quantities can be illustrated on the basis of a calculation whereby, when full, the natural gas pipeline will contain around 15,700 m³ of flooding water (inner diameter 0.5 m, length 80 km). If the pipeline is emptied with a pipe that is 30 cm in diameter and the dewatering rate is 1 m/s, the flow rate obtained is approximately 0.07 m³/s. With these sample values a continuous flooding run with a volume of water corresponding to the volume of the pipeline would take three days. That volume of water would, for example, contain around 1,000 kg of sodium bisulfite (at 65 mg/l).

When using oxygen scavengers or biocides, the water removed is led into a basin for the settlement of solids and any impurities in them. Following the settlement process, the water is pumped into a marine area where mixing will take place rapidly. If the flooding is carried out using filtered water, there is no need for settling and the water can be in a controlled manner into the sea. The initial water dilution and mixing as well as the mixture – plume – created near the discharge area was outlined using Cormix (Mixing Zone Expert System, United States Environmental Protection Agency) modeling. This calculation model is not an actual water system model to solve precise flow fields, but it does, however, use flow and movement equations to provide mathematical forecasts of the shape, movement and mixing rate of the plume, i.e. the wastewater mixture created in the given circumstances. The calculation model provides an idea of the initial dilutions.

In the calculation, the discharge rate was 1 m/s and water of equal density was discharged from a round pipe into a flow at the rate of 10 cm/s (Figure 6-15). The graph shows that the flooding water is already diluted over a distance of 100 m by around 1:90, which means the concentration of e.g. sodium bisulfite falls clearly below 1 mg/l.

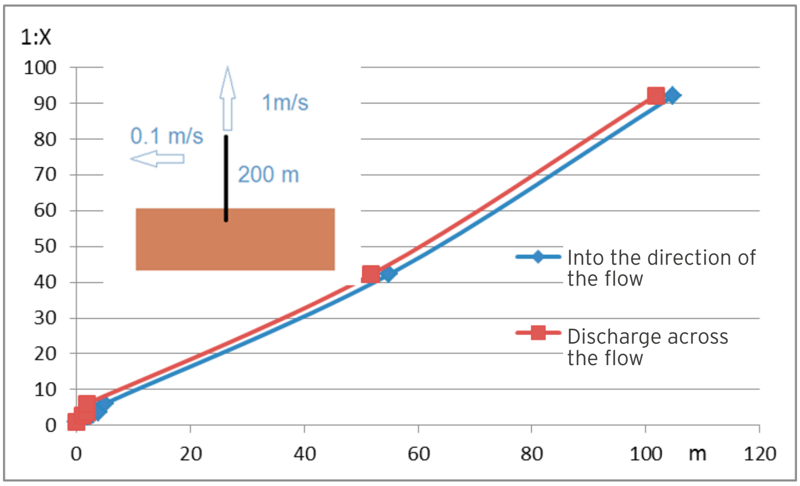


Figure 6-15. Calculated graph for the dilution of discharge water at the mouth of the discharge pipe.

The impacts of flooding water were monitored in Portovaya Bay, Vyborg, Russia, in conjunction with the Nord Stream gas pipeline project. The impacts concerning the levels of oxygen, salinity and solids in water were low and may also have been caused by natural variation due to weather conditions. No harmful substances were detected in conjunction with pressure testing and flooding. The substances used for flooding water treatment were sodium bisulfite and sodium hydroxide.

Due to the small volume of water and the short duration of discharge, the impact of flooding water can be assessed as low on the basis of the experiences gained from the Nord Stream project.

State of the marine area

The temporary and mostly low turbidity, minor increase in vessel traffic and the short-term load arising from pipeline flooding caused by natural gas pipeline construction will not significantly deteriorate the ecological status of the area's coastal water bodies or on the whole in western Gulf of Finland. The minor flow changes and possible other changes in water quality caused by the pipeline during operation will not have an impact on the status of marine water either. Therefore the Balticconnector natural gas pipeline project is not estimated to jeopardize or significantly delay the achievement of a good status in the marine area.

6.5.2.2 Impact of operation and maintenance

The pipeline will not have an impact on water quality in normal situations during operation. During operation, the impacts of the pipeline on the marine environment will mainly be restricted to minor flow amendments due to morphometric changes caused by the pipeline itself and its construction (covering and protection) in areas near the pipeline, such as increased turbulence around the pipeline at faster bottom flow velocities. Changes in flow velocities and directions may affect the transport and accumulation of materials in the close vicinity of the pipeline. According to measurements carried out for the Nord Stream project, the impacts only extend up to tens of meters from the pipeline.

Potential impacts of pipeline anti-corrosion measures, coating and protective anodes on water quality are to do with substances, mainly metal ions, released from materials during pipeline lifecycles. The release of metal ions depends on the total quantity of material and the ion release rate. The zinc/aluminum anodes installed in the pipeline may cause a slight increase in the concentrations of zinc and aluminum in the immediate vicinity of the pipeline, but the concentrations will rapidly become smaller in the sea due to currents and water turnover. Most metals will settle and accumulate in the bottom sediment. This, however, is affected by a variety of factors, such as oxygen and pH levels. In addition to aluminum and zinc, anodes may also contain small amounts of other metals and impurities. The impacts of anodes on metal concentrations in seawater were monitored in conjunction with the construction of the Nord Stream gas pipeline. The metal concentrations were generally in the same magnitude near the pipeline and in the reference areas.

During the operational phase the impact on the water quality in the Gulf of Finland may also arise due to the restricted water exchange in the near-bottom layer over the constructed (and protected) pipeline. Since the planned design foresees to fill in some deeper sections (to reduce free span of the pipe) and cover the pipeline with 1 m thick gravel layer in sections where it crosses the shipping lines, the presence of pipeline has some impact on water exchange in the deeper layer. If considering the entire cross-section, the change in the cross-sectional area is not significant. However, if considering only the deep layer below the halocline (approximately 60 m), then the change in the cross-sectional area could influence the water exchange of the densest water. The deepest section of the pipeline is situated in Estonian waters between KP 54 and KP 68. The pipeline is planned to be covered from KP 46 to KP 59, and from KP 62 to KP 70. According to the depth profile, the total area below 60 m along the section KP 54–68 is about 290,000 m². A total of 11 km of this section will be covered with gravel. Assuming that the height of the pipe and gravel is 1.4 m above the seabed, the estimated filled cross-sectional area is 15,400 m². This is about 5% of the cross-section below the halocline. Although the water exchange will not be reduced and will be about the same value (since the halocline depth also fluctuates; it is not fixed), there will most probably be a certain impact near the bottom flows. No model with such precision is currently available to assess this impact quantitatively.

Summary of the significance of the impacts

Although the dispersion modeling results for re-suspended particles indicated that floating material can be carried quite far toward both shorelines in the bay, most of the material would settle in the immediate vicinity of the work area. A certain amount of sediment can be transported and settled outside Lahepere Bay toward the open sea from the tip of Ihasalu peninsula only for ALT EST 2 in the case of strong northwesterly winds.

The impact of harmful substances lifted into the water column during the construction of the Balticconnector pipeline will be smaller than it was during the construction of the Nord Stream pipeline. However, considering the planned procedures for preparing the route and for protecting it in areas of high vessel traffic and in coastal waters, the construction work will definitely have a certain impact on the ecosystem of the gulf.

The maximum amount of phosphorus released as a result would be up to 1.2% of the phosphorus loads from the mainland and phosphorus released from the sediment in anoxic conditions.

Table 6-4. Impact significance on water quality. C = construction phase, O = operating and maintenance, L = Lahepere bay, OS = open sea.

Impact significance		Magnitude of change								
		Very high	High	Moderate	Low	No change	Low	Moderate	High	Very high
Sensitivity of receptor	Low	High	Moderate	Low	**O/OS Low**	No impact	Low	Low	Moderate	High
	Moderate	High	High	**C/OS, L Moderate**	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.3 Impact on marine benthos

5.5.3.1 Impact on phytobenthos

As seabed flora only exists in the coastal euphotic zone, the impact on seabed flora covered in this paragraph only applies to the Lahepere Bay area. The most diverse phytobenthic community occurs at a depth of 1–5 m. In deeper sea, where sunlight does not penetrate, there is no seabed flora.

6.5.3.1.1 Impact of construction activities

The negative impact on seabed flora will occur during construction work.

Laying the gas pipeline in the phytobenthic zone will principally cause direct physical damage to the communities of seabed flora. The greatest damage to seabed flora is expected in the shallow sea area, where phytobenthic communities are more diverse and have the highest biomass.The impact is spatially limited as it will mainly relate to the work area (ca. 50 m), where intensive construction work and excavation of sediments will be carried out.

In order to protect the planned gas pipeline from vessel traffic and ice, it is planned to install the pipeline into a trench which will be covered with rocks. Within Lahepere Bay from a depth of ca. 12 m, the pipeline will be laid directly onto the seabed, and then covered with a layer of rocks. The proposed rock filling will cover an area of 5.4 in length and ca. 10 m in width. The area of rock filling will cause an irreversible change in the structure of the seabed flora community as the existing sandy seabed will be replaced with a hard seabed. Seabed flora are expected to recover from physical damage in about 2–5 years (*Borja 2010*) after the construction work. In the area covered with rocks, a development of hard bottom phytobenthic communities, constituted by species like bladderwrack (*Fucus vesiculosus*), *P. littoralis*, *P. fucoides*, *black carrageen*, *C. tenuicorne*, etc, is expected. Rock filling is not a suitable substrate for the development of higher plant communities.

In the area of the ALT EST 1 alternative, the seabed is predominately soft and sandy sediment. The phytobenthic communities in this area are mainly formed by higher plants, and have a high biomass value. During the preliminary sea environmental study (*TTÜ MSI 2013*), the existence of meadows of common eelgrass (*Zostera marina*) was recorded in the ALT EST 1 area. Meadows of common eelgrass are valuable biotopes that play an important role in preserving biodiversity and contribute to abundance of marine fauna. In Lahepere Bay, common eelgrass is distributed on the soft bottom in the southern part of bay. Biotopes of eelgrass are mainly endangered by eutrophication and work involving the displacement of seabed sediments in shallow sea (*HELCOM 2013*). Building a rock cover over eelgrass meadows can permanently damage eelgrass beds in the vicinity of ALT EST 1. However, modeling results of spatial eelgrass distribution (*TÜ EMI 2014*) indicate that beds of eelgrass can be affected by construction work in an area of ca. 2.25 ha, where probability of eelgrass occurrence is low (about 0.25). The predicted impact can be considered as being low negative and to mitigate this, it is advisable to use technology that allows spatially less damage to the seabed during construction work and does not require the use of continuous rock filling in shallow water.

In the shallow coastal sea area of ALT EST 2, a rocky type of seabed with characteristic communities of phytobenthos dominate. At a depth of 6–7 m, the rocky seabed gives way to sandy sediments with a lower biodiversity of seabed flora. In view of this, it can be assumed that this alternative will have a lesser impact on phytobenthic communities since once construction work has been completed, the rock filling will enable the recovery of seabed flora characteristic to the area.

Indirect negative impact to seabed biota may occur through the transfer of suspended matter and pollutants into the water during construction and maintenance work, and through the settling of suspended matter in the phytobenthic zone. Settling of suspended matter on seabed flora may inhibit its photosynthesis and growth ability because a layer of sediment on the plants constrains light rays from penetrating to the parts of the seaweed that are responsible for photosynthesis. Also enriching the water column with suspended matter will temporarily deteriorate water transparency, restricting sunlight penetration into deep areas. The character of the seabed material is an important factor in the extent to which suspended matter is concentrated and dispersed during work on the seabed. Coarse sediments will generally settle faster and closer to the work site. Dispersion modeling results for re-suspended particles (see section 6.5.1) have shown that most of the settling (with suspended matter > 10 g/m²) occurs in the immediate vicinity of the work area within ca. 2–5 days, at ca. 600 m on either side of the pipeline axis. Negative impact is temporary, but it should be considered as moderate, because of the extent of dispersion and concentration of suspended fine-grained sediments may remain longer in the water column and extend over a larger area, but their concentrations in the water are generally very low and are unlikely to produce a negative impact. ALT EST 2 would result in a lesser overall impact on benthic flora.

It is also unlikely that pollutants would impact on seabed, because according to a preliminary study of the marine environment (*TTÜ MSI 2013*), the seabed sediments in Lahepere Bay are not polluted,.

6.5.3.1.2 The impact of operation and maintenance

Physical damage to the seabed flora is also possible during maintenance work, but the negative impact in this phase is much lower than in the construction phaseAny maintenance work is usually short term and involves a limited area, and in this case the impact on benthic flora is regarded as minor.

Also, the existence of rock filling to protect the pipeline on the seabed can be considered an impact during the operation phase. This impact on the seabed flora is described in more detail in section 6.5.3.

6.5.3.2 Impact on zoobenthos

The benthic fauna in the project area is characterized by the variation in zoobenthic communities depending on the seabed type and depth. Open sea communities have less species compared to the shallow Lahepere Bay, and consist of opportunistic species, which are more tolerant to changes in the marine environment. The impact on benthic fauna depends largely on the nature of the planned work and the structure of benthic fauna in the construction area.

6.5.3.2.1 Impact of the construction activity

As in the case of benthic flora, the biggest impact on benthic fauna will be during construction, when the most extensive sediment displacement work occurs.

Work during the construction phase is expected to directly damage benthic fauna in the area of activity. The area of potential direct impact in the shallow water of Lahepere Bay, where dredging will takes place, is approximately 50 m wide. In shallow water, the pipeline will be laid in the trench and be covered with a layer of rocks for protection. Starting from a depth of approx. 12 m in Lahepere Bay, the pipeline will be laid directly onto the seabed and covered with a layer of rocks (*Ramboll 2014a*).

Damage to the benthic fauna in shallow water can be expected to be greater compared to that in the open sea, since the ecosystem is not as rich in the latter. There is a chance that the benthic fauna ecosystem will recover if there is a suitable substrate on the seabed. However, recovery will largely depend on the surrounding environmental conditions and will take 1–5 years (*Kotta 2009*; *Borja 2010*). Since the negative impact is temporary and limited in scope, it can be classified as moderate.

Rock fill on a sandy seabed permanently destroys soft-bottom communities and creates secondary substrata, i.e. "artificial reefs". These reefs are a base for the development of benthic fauna communities specific to hard seabeds. Artificial reefs are created around the world to restore damaged habitats (*Miller 2009*; *Fariñas-Franco&Roberts 2014*). The key species living on hard substrata in Estonian coastal waters are the bay mussel (*Mytilus trossulus*) and the bay barnacle (*Amphibalanus improvisus*). The bay mussel forms large colonies on suitable substrate, and these colonies are able to filter large amounts of water, reducing the concentration of phytoplankton and improving water transparency. These species are also a food source for bottom-feeding fish and numerous other pochards and other water birds living in Lahepere Bay. Therefore the creation of "artificial reefs" can improve the food base of animals feeding on zoobenthos. However, artificial reefs are not a natural habitat for the ecosystem of Lahepere Bay, and there is no ecological reason to create them. The impact on macrofauna in the Lahepere bay ecosystem can therefore be regarded as negative and minor. Depositing the sediments removed by dredging will bury the zoobenthos under the sediment, thereby destroying the communities. After construction work has been completed, the benthic fauna in the area is expected to recover. However, recovery of the initial benthic fauna communities depends on the type and quantity of deposited materials and the lifestyle of the organisms (*Powilleit 2009*). The spatial extent of the impact depends heavily on the surface area of the deposited sediments.

The area of activity in the open sea in Estonia has a width of about 10 m, since the pipeline will be laid straight onto the seabed. The greatest impact on zoobenthos in the open sea will caused by blasting. Blasting work has been planned at a distance of 16.2 km from the coast and along the 18 km of planned pipeline route in Estonian waters. Blasting work has only been planned in the deep sea at a depth of 5189 m and in an area characterized by soft-bottom zoobenthic communities with a poor species composition and high biomass. In the planned activity area at a depth of greater than 8085 m, the zoobenthos may be absent due to the lack of oxygen (section 5.1.8). Blasting work will temporary destroy benthic fauna in a limited area. The magnitude of the impact on zoobenthic communities depends strongly on the quantity of explosives, the extent of the damaged area, the presence of benthic fauna, and depth. Since at the time of this assessment, the extent of planned blasting procedures had not been finally decided, it is not possible to accurately assess the magnitude of the impact. Generally such impact is temporal and spatially limited, and the benthic communities are expected to recover. Taking into account the initial data on blasting work, it can be assumed that blasting will have a moderately negative impact on the benthic fauna in the open sea. The overall impact of blasting on zoobenthic communities in the project area will be minor. Benthic fauna can also be affected by the suspended matter generated during construction activities. Depending on the nature and amount of the suspended matter, the clogging of the siphons of filter feeder molluscs can occur. Lahepere Bay is dominated by coarser sediments and according to the modeling results (section 6.5.2), most of the particles will settle within 5 days within a 600-m radius of the work area. The open sea is dominated by finer sediments. Blasting work in the open sea can be expected to cause the largest quantity of suspended matter. Finer particles can remain in the water for a longer period of time and spread to a larger area, but their concentration decreases with the increase in distance from the work area. As a rule, the indirect impact on suspended matter on zoobenthos is temporary and limited in scope, and therefore is regarded as having a low negative impact.

Organic suspended matter brought about by the extraction and displacement of sediments can improve the food base of certain benthic fauna species (the bay mussel (*Mytilus trossulus*), the Baltic clam (*Macoma balthica*), etc.) and therefore possibly increase their abundance and biomass in the future. The abundance and high biomass of zoobenthos can, in turn, result in the over-consumption of oxygen in the deep sea, and therefore cause living organisms to die. Sediment analysis reports conducted by Ramboll Analytic labs (*TUT MSI 2013*) showed low concentrations of organic matter in the sediments of Lahepere Bay. The sediments in the open sea vary greatly in their concentration of organic matter. The impact on zoobenthos in Lahepere Bay and the areas in the open sea where it is planned to lay the pipeline directly onto the seabed can be classified as neutral. Blasting can cause more organic matter to be released into the water, but since the large concentrations of fine suspended matter will occur only in limited areas, the overall impact on project area zoobenthosis is regarded as minor.

The impact of seabed intervention work on zoobenthos refers also to the release of harmful substances and nutrients from the sediment. The release of large amounts of harmful substances into the water can disrupt the vital activities of benthic fauna, it can collect in the tissues and migrate to the top of the food chain. According to the study on the distribution of harmful substances along the planned pipeline in Estonian territorial waters and exclusive economic zone, the concentration of harmful substances in the upper 20 cm layer of sediment is relatively low (*section 6.5.2.1; TUT MSI 2013*). It is difficult to estimate the quantity of harmful substances which will enter the food chain and accumulate in organisms. Based on the study conducted and water quality assessment in section 6.5.2.1, it can be concluded that contaminants will have a minor impact on benthic fauna.

Commissioning

The natural gas pipeline will be tested and cleaned before commissioning. The cleaning process will involve the pipeline being filled with seawater containing sodium bisulfite ($NaHSO_3$) and/or biocide. After testing, the cleaning water is usually discharged into the sea, but the planned activity area is unknown. Since it is not known how the benthic fauna can change due to the cleaning water, if it contains biocides, it will not be allowed to discharge the cleaning water into Lahepere Bay and its vicinity.

6.5.3.2.2 Impact of operation and maintenance

Physical damage can be inflicted on the benthic fauna also during repair and maintenance work, but the negative impact will then be much less significant and be limited only to the repair area when compared to the construction phase and the whole pipeline length. Therefore, the impact is minor.

The existence of a rock barrier or secondary substrate on the seabed can also be considered as an impact during pipeline operation. The impact of a permanent rock layer on the zoobenthos has been described in detail in section 6.5.3. This negative impact on benthic fauna can be regarded as low.

Summary of the significance of the impacts

The impact of the planned activity on benthos will be greater in shallow Lahepere Bay than in the open sea. Recovery of the benthic communities depends on the surrounding environmental conditions and will take

1-5 years. The overall negative impact on zoobenthic communities is temporary and limited in scope, it can be regarded as moderate.

Blasting work will temporary destroy benthic fauna in a limited area. The magnitude of impact on zoobenthic communities largely depends on the quantity of explosives, the extent of the damaged area, the presence of benthic fauna, and depth. Since at the time of this assessment, the extent of planned blasting procedures had not been finally decided, it is not possible to accurately assess the magnitude of the impact. Generally such impact is temporal and spatially limited, and the benthic communities are expected to recover. Taking into account the initial data on the blasting work, it can be assumed that blasting will have a moderately negative impact on the benthic fauna in the open sea. The overall impact of blasting on zoobenthic communities on project area will be minor.

In the case of the ALT EST 2 in Lahepere Bay, zoobenthos on both soft and hard substrata will be damaged. Hard-bottom communities are expected to be damaged in small area. In the case of the ALT EST 1 alternative, only soft-bottom communities would be damaged, but construction work and rock filling are planned over a spatially more extensive area, namely along the entire Lahepere Bay. Without mitigation measures, more extensive permanent destruction of natural benthic habitats is expected than with ALT EST 2. After mitigation measures for benthos, described in chapter 9, the natural habitats can be expected to recover in both cases. Nevertheless, ALT EST 2 will still have less impact on benthos in the project area.

During operation and maintenance the possible negative impact is minor.

Table 6-5. Impact significance on marine benthos. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	**C** **Moderate**	**O** **Low**	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.4 Impact on plankton

Project activities and their potential impact on plankton are assessed in the project area of Lahepere Bay as follows:

Construction phase – re-suspension and movement of sediments during work carried out on the seabed, which may cause changes in the species and numerical dynamics of plankton.

Commissioning phase – intake of seawater into the gas pipeline, exhaustion of pressure test water and potential biocides, which may cause changes in the species and numerical dynamics of plankton.

Since plankton floats in the water column, the pipeline, constructed on the seabed, will not affect the species and distribution of plankton in the project area during the operational phase. Consequently, there is no predictable impact on plankton populations of during the operational phase of the pipeline, which is not included in this assessment.

6.5.4.1 Impact of construction activities

As a result of the work carried out during the construction phase, an additional amount of suspended particulates will enter the water column, and nutrients and pollutants contained in the sediments may re-enter circulation. These are the main impacts of construction activities potentially impacting plankton in the project area, influencing its species and dynamics. During a short period (approximately 2–5 days), water transparency will also decrease due to the sediments (*TTÜ MSI 2014*).

6.5.4.1.1 Additional nutrients in the water column

The increase in the concentration of suspended particulates in the water column during the construction phase is caused by activities on the seabed and blasting. Blasting results in more suspended particulates, and these will remain in the water column for a longer period (*TTÜ MSI 2014*). According to the plan, blasting will only take place in the deeper area (> 50 m) (*Ramboll 2014a*). Based on modeling, the sediments will not float higher than 5 m from the seabed (*TTÜ MSI 2014*). This means they will not reach the euphotic zone where they could impact plankton. The same applies for other seabed activities in deep areas.

However, concentrations deviating from the natural level reaching the euphotic zone may impact the dynamics as well as the species of plankton. Nutrients (mainly nitrogen and phosphorus) reaching the euphotic zone may increase the growth and distribution of phytoplankton, and thus increase the risk of eutrophication.

This project consists of regional activities of a temporary nature, and therefore any temporary changes in the dynamics of plankton are not significant on a larger scale. Plankton consumes nutrients fast, and this will not result in a significant change in eutrophication. It should also be noted that changes resulting from the activities are difficult to discern from the general characteristic framework of seasonal variations in plankton. It is therefore presumed that the additional nutrients released during construction activity will not have a significant impact on plankton.

6.5.4.1.2 Pollutants in the water column

Activities on the seabed, like dredging, subsea rock installation and the installation of pipeline, can cause a re-suspension of pollutants from sediment into water column. This in turn can negatively affect plankton. Problematic pollutants include heavy metals and organic compounds, including polycyclic aromatic hydrocarbons.

Plankton is able to absorb and accumulate different pollutants in its tissue (*Kelly 1999* and *Stoecker 1986*). The extent of the potential impact on zooplankton and phytoplankton depends on the functioning mechanism of pollutants, and the duration of exposure. Heavy metals usually dissolve more easily than organic compounds, and considering the short duration of exposure to resuspended pollutants, acute toxicity due to temporary resuspension of heavy metals is therefore the most likely mechanism impacting plankton (*Kelly 1999* and *Stoecker 1986*). The dynamics of plankton naturally varies greatly in the Baltic Sea, thus making it difficult to discern the impact of toxic substances from natural variations. Lahepere Bay is located in an area with relatively minimal human interference. According to the preliminary study (*TTÜ Meresüsteemide Instituut 2013*), the concentrations of heavy metals in the bottom sediments practically did not exceed the target numbers applicable for the elements studied. Only the concentrations of cobalt and nickel slightly exceeded the target numbers applicable for the elements studied, but even then remained significantly below the limit established for industrial areas. It can be presumed that the concentration of heavy metals in the water column will not increase significantly during the construction phase. The concentrations of organotin compounds TBT and TPT were lower than the detectionlimit of 1 µm/kg in most stations. The substances exceeded the detection limit at only four deep stations. It is unlikely that the concentrations of TBT and TPT in the water column would exceed the concentration and impact plankton during the construction phase. The concentrations of dioxides and radionuclides in the upper layer of sediment also remained within the limits characteristic for the Gulf of Finland (*TTÜ Meresüsteemide Instituut 2013*).

In conclusion, it can be said that an increased concentration of heavy metals and organic compounds in the water column is an unlikely and temporary local phenomenon. The toxic impact on plankton of pollutants in the project area is minimal or non-existent, and is therefore unlikely to be discernible from the natural dynamics of plankton.

6.5.4.1.3 Decrease in water transparency

Sediment particles moving in the water as a result of construction work will limit the penetration of light in the water. As the growth of plankton directly depends on solar energy, this will have a negative effect.

Based on the modeling results for this project, the sediments will not rise higher than 5 m from the seabed as a result of blasting or other construction work (*TTÜ MSI 2014*). Therefore, in the deeper areas there is no foreseeable spread of sediment to the euphotic zone, where it could impact plankton. In shallow areas, where water will be clouded in the upper layers, the sediments will only float for approximately 2–5 days. Thus, it can be concluded that the decrease in water transparency will not have a significant impact on plankton.

6.5.4.2 Impact of operation and maintenance

During the pre-commissioning phase, the pipeline will be internally cleaned of rust and any organic substance. Seawater from which oxygen has been separated will be used for this purpose. The use of biocides (glutaraldehyde or sodium hydroxide) is also an option (*Ramboll 2014a*).

During capacity testing and commissioning, the potential impact on plankton will be limited to the intake of seawater to the pipe and release of pressure test water. Plankton in the test water will be destroyed. Pressure test water enriched with biocides in the sea will have a negative impact on plankton. High concentrations of biocides can destroy plankton.

In general, the quantity of seawater fed into the pipeline is small, and its impact on the plankton population as a whole is insignificant. The water released from the pipeline will be diluted and mixed with seawater, resulting in the dilution of harmful concentrations. In the presence of ice, the movement of water will decrease and the dilution period will be longer. However, during the winter the concentration of plankton in the water column is also lower. Therefore, the impact on plankton during the precommissioning phase is assessed as insignificant.

Summary of the significance of the impacts

The additional nutrients released and decrease in water transparency during construction activities will have no significant impact on plankton. The toxic impact on plankton of pollutants in the project area is minimal or non-existent, and is therefore unlikely to be discernible from the natural dynamics of plankton. The impact on plankton during the precommissioning phase is assessed as insignificant.

There will be no significant impact on the plankton in the area of activities of the Balticconnector pipeline project.

Table 6-6. Impact significance on plankton.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	**No impact**	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.5 Impact on fish fauna

The following is an assessment of the impact of Balticconnector gas pipeline construction and operation on the fish fauna in the project area.

6.5.5.1 Impact of construction activities

Construction activities relating to the Balticconnector pipeline will have a moderate and reversible impact on the local fish fauna. This will affect local individuals rather than the whole species. Construction will cause noise, increase the concentration of sediments and substances in the water column, result in changes and disturbances on the seabed, and changes in the food basis for fish.

6.5.5.1.1 Noise

Noise is one of the most important factors impacting fish in the Balticconnector project. When assessing the impact of noise on fish fauna, it should be taken into account that this has not been a subject of extensive research. The results relate to specific species, and it might not be possible to apply the results to natural conditions (i.e. lab experiments). This is therefore an estimated "worst case scenario" analysis based on existing information. Since very little research has been dedicated to studying the hearing ability of fish, the assessment of noise impact is based on a so-called model species, whose noise sensitivity has been specifically studied. It should also be noted that since a lot of test results have been obtained in a laboratory, they can be rather inaccurate when applied to natural conditions.

The main activities causing noise during the construction phase are related to seabed intervention work like blasting, and the movement of ships in the area due to construction activities (see Figures 6-19 and 6-20). The pipeline will be constructed at an estimated speed of 4-5 km/day (incl. pipeline welding, pipeline laying etc), which means that the noise will be limited to the specific daily duration. The radius of critical disturbance for fish is estimated to be approximately 50 m. In the case of blasting, the radius of significant impact can be approximately 3-5 km (these distances are estimated based on the probability of hearing damage among pinnipeds).

The impact of noise on fish varies between species, and depends on the hearing range (Hz) of a certain species. The impact of noise on fish can be presumed if the noise overlaps with the hearing frequency and level of the species, and exceeds the level of background noise. The average level of sound pressure of background noise in the Gulf of Finland on the Estonian side is approximately 65 dB re 1 µPa depending on vessel traffic. This means that if the noise during construction is 123195 dB re 1 µPa, the background noise is exceeded by 58 to 130 dB.

According to different assessments, the general hearing frequency studied for fish is from 30 Hz to 1 kHz, but the ability of certain species to hear lower (20 Hz or infrasound) and higher (20 kHz or ultrasound) frequencies has been studies as referred to below (*Thomsen 2006*).

The following list includes species whose hearing has been studied further.

Dab (Limanda limanda)– results can be applied to European flounder (*Platichthys flesus trachurus*)and turbot (*Scophthalmus maximus*) inhabiting the project area. The species is not very sensitive to sound and can only hear in a limited range (30250 Hz). The threshold of dab hearing is frequency dependent, and it has best sensitivity at 110 Hz, with a threshold of 89 dB re 1 mPa. Therefore the dab represents fish with a low hearing sensitivity (Figure 6-16).

Atlantic salmon (Salmo salar) – only reacts to low frequency sounds, and best hearing is at sound pressure level 95 dB re 1 µPa 160 Hz. In conclusion, the hearing of Atlantic salmon is considered rather limited due to its narrow frequency range, low ability in differentiating sounds, and limited general sensitivity (Figure 6-16).

Atlantic cod (Gadus morhua) – hearing threshold at 75 dB re 1 µPa 160 Hz. There are findings on the ability to hear infrasound lower than 1 Hz (*Sand 1986*). Cod is rather efficient at differentiating sounds from various sources and distances (*Buwalda 1983 and Schuijf*, Figure 6-16).

Atlantic herring (Clupea harengus) – the findings are probably transferrable to Baltic herring, Baltic sprat and twait shad belonging to the same family; according to different assessments they are able to hear relatively well, and are sensitive to sounds. They can hear between frequencies of 30 Hz to 4 kHz. The threshold of Atlantic herring hearing has best sensitivity at 100 Hz, with a threshold 75 dB re 1 mPa (Figure 6-16).

European eel (Anguilla anguilla) – can hear low frequency sounds, infrasound (Figure 6-17).

Goldfish (Carassius auratus) and other fish of the carp family (in the project area for example Prussian carp, Crucian carp, common roach, common bleak) also hear quite well, and their hearing ability is assessed to be higher than average (Figure 6-17).

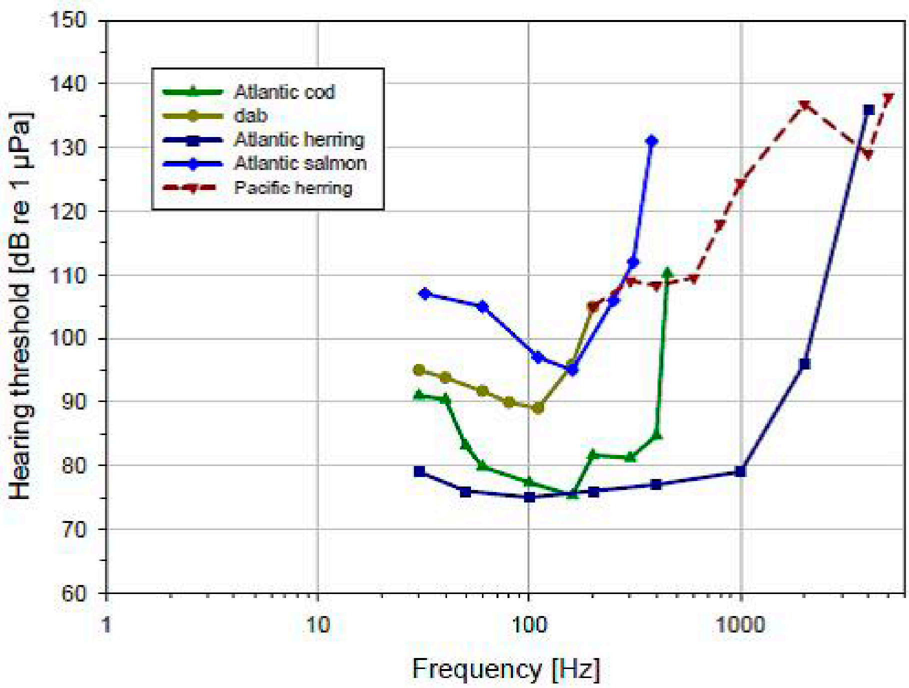


Figure 6-16. Audiograms of salmon, cod, two species of herring and dab (*Thomsen 2006*).

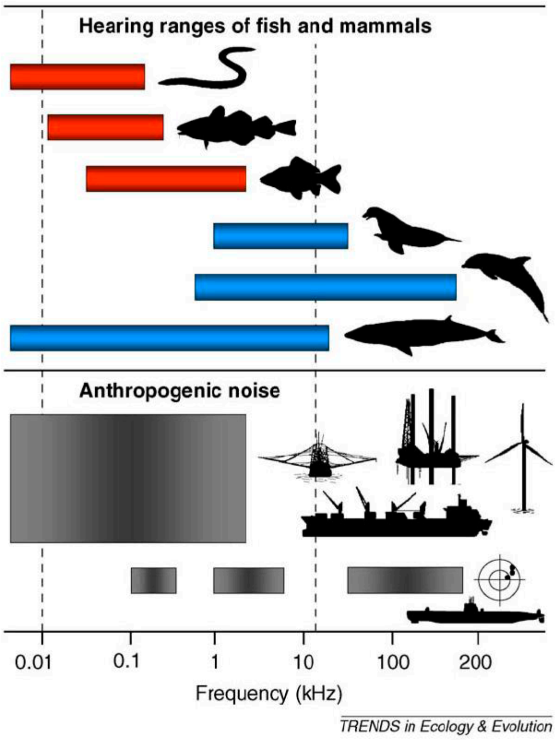


Figure 6-17. Comparison of the hearing range of fish (eel, cod and goldfish) and sea mammals (seal (*Zalophus californianus*), dolphin (*Tursiops truncates*) and whale (*Balaenoptera physalus*), and the frequency range of anthropogenic noise (*Slabbekoorn, 2010*).

It seems the frequency of noise generated by construction activities will be within the hearing range of most species.

Underwater noise can be divided in two categories: continuous and impulsive:

- Continuous broadband noise is generated by moving sources like ship noise, or by stationary sources like vessels during dredging operations or pipelaying.
- Impulsive noise is produced by blasting. For areas of bedrock, blasting will be necessary as conventional dredging may be slow and expensive.

The impact of impulsive and continuous noise on fish is different. **The impulsive noise** caused by blasting is most harmful for fish. A blast generates a fast-moving shockwave, which differs from the surrounding environment by its density and pressure, and can cause serious damage to tissue and internal organs as well as death among fish at certain distances (see Figure 6-19 and Figure 6-20). The radius of acute impact is approximately up to 900 m from the blasting source (estimated based on the probability of permanent hearing damage among pinnipeds) (*Wright 1998* and *Klauson 2014*). As the louder blasting noise may not overlap with the hearing range of all species, injuries among fish have been detected at a sound pressure level of 153–180 dB re 1 µPa. Species like Baltic herring, Baltic sprat, and cod which have an air bladder are more affected than dabs.

Different calculations indicate that the noise caused by the detonation of 20–50 kg of TNT directly at the source is approx 248–257 dB (*Ramboll 2014a*). The noise report of this project calculated the noise level due to blasting at different points along the border of the Natura 2000 site at Pakri Peninsula (Figure 6-18) with an initial noise source level of max 230 dB. Levels of sound pressure varied between different points by max. 16 dB. Of the points assessed, the loudest sound was recorded at point NLP18 – 173 dB re 1 µPa, located further away from the shoreline and the closest to the potential blasting sites (2.4 km). A sound pressure level 173 dB can cause serious injuries to fish (*Thomsen 2006*). A number of species including cod, as well as periodically Baltic herring that prefer deeper water, can move in this area of open sea. This, however, affects only certain individuals in the area and does not concern either species as a whole.

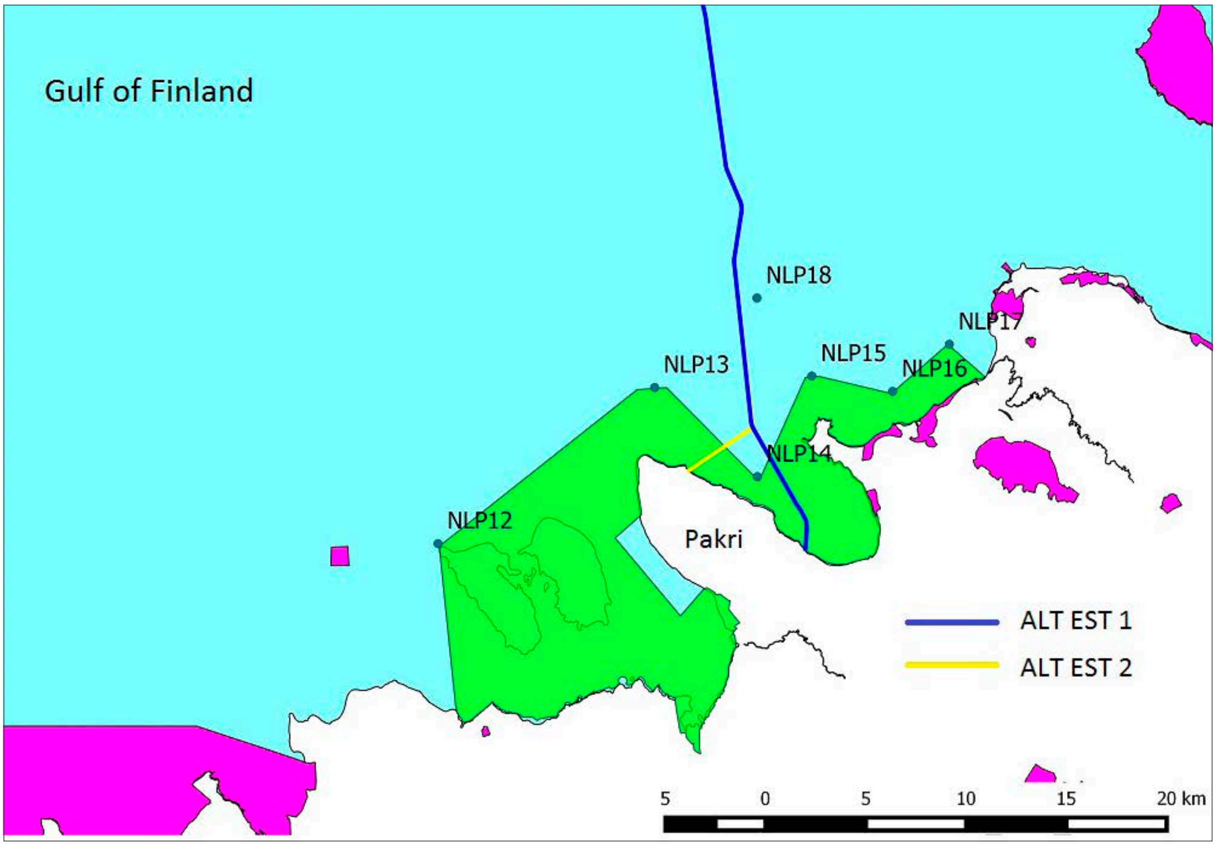


Figure 6–18. Noise points NLP12-NLP18 on the borders of the Natura 2000 site in the project area (*Klauson 2014*).

At point NLP14, which is the closest to the spawning areas in Lahepere Bay (11 km from the source of noise), the measured level of noise was 151 dB, which in turn exceeds background noise by approx 86 dB. This is borderline noise, which can cause different adverse effects on fish, and in turn drive them away from the area. This can have an adverse impact on both individuals and the species as a whole. However, the impact is reversible, meaning that the fish will return after the disturbance has ceasedNevertheless, it is recommended to use warning signals immediately before blasting to drive fish away from the danger zone and thus reduce the number of individuals getting injured.

The level of noise was lowest at point NLP12 – 147 dB. This is a shoreline area of Pakri islands, 21 km from the source of noise, and a probable spawning area of a rare species of whitefish. The noise may disturb the spawning of this species, but the impact is temporary and is estimated to affect only one or a maximum two spawning seasons (*Ramboll 2014a*).

Continuous noise acts as a stressor for fish, and can cause negative changes in their physiological parameters (increased heart rate, secretion of stress hormones), reproductive ability, and growth rate (*Vella 2001*; *Wysocki 2006*; *Graham 2008* and *Buscaino 2010*). In addition, noise exceeding background noise can mask t communication between animals (*Wahlberg 2005*), affect the relationship of predator-prey, and deter species from the area (Figure 6–19. ; *Richardson 1995*). It is highly likely that the species will primarily leave or avoid an unfavorable environment, (*Nedwell 2003; Nedwell, 2004* and *Nedwell, 2003b*) which is associated with a risk of the constant departure of fish. However, this topic has been researched very little. A probable important factor is the duration of noise – noise with a longer duration is definitely more harmful.

The noise report of the project estimated the sound pressure levels due to noise caused by pipelaying at the same representative points in the area of Lahepere Bay. The variation of noise was 24 dB, and noise was the loudest at point NLP18 147 dB re 1 μPa, which is the closest to the pipeline route. The lowest sound pressure was measured at point NLP12 – 123 dB re 1 μPa, on the shoreline of Pakri islands. Pipelaying noise is continuous and less intense compared to blasting.

The assessed noise level near the spawning areas in Lahepere Bay was 143 dB re 1 μPa, exceeding background noise by 78 dB.

It is highly likely that this noise level would have a negative impact on local spawning fish such as the Baltic herring, whitefish, flounder and garfish. The noise may disturb the spawning of these species, but the impact is temporary and is estimated to affect only one or a maximum two spawning seasons.

Movement of ships in the area due to construction work will also cause continuous noise (185–190 dB), which can disturb fish in close vicinity of the vessel (estimably about 50 m). However, this noise cannot generally be differentiated from usual traffic, and its impact will not exceed the impact of construction work and blasting.

The continuous noise associated with pipelaying and other construction work related to the Balticconnector pipeline, as well as traffic, is estimated to be temporary and therefore have a moderate and reversible impact on the fish.

The most important fish species to be monitored in the area of Lahepere Bay are numerous spawning and feeding species and/or species valuable in terms of nature conservation. The area is an important spawning location for garfish, Baltic herring, flatfish, and probably perch. In October–November, a rare form of whitefish is known to spawn in nearby Pakri Bay. Construction work can potentially disturb this species during the spawning season, and may temporally deter it from the area. It is estimated that construction work will affect only one or a maximum two spawning seasons.

From the nature conservation perspective, the most important species in the European Directive include whitefish, salmon, and sculpin. Another important species in Estonia is the eel, which is periodically also numerous in Lahepere Bay.

Species spawning in Lahepere Bay spawn in shallow coastal waters from the beginning of April to the end of July. Calculated noise levels during the construction period considerably exceed the background noise, and it can be concluded that impulsive as well as continuous noise can disturb spawning fish – most of all Baltic herring, which is the most sensitive of the spawning fish to noise. Temporary negative impact on individuals of other species cannot be excluded. Construction noise exceeding background noise by 58 dB can also, to a certain extent, impact the rare whitefish spawning on the Pakri coast. However, the extent of the disturbance is difficult to define. As fish are more sensitive to disturbances during the spawning season, and since Lahepere Bay is an important spawning area for several species (mentioned above), it is recommended to avoid construction work during the spawning season from April to July.

During periods other than the spawning season, construction work can have a significant negative impact on cod and Baltic herring, as well as on other species numerous in the deeper areas, including the blasting area. However, the effect is mostly considered on an individual level, while the species as a whole is not significantly affected.

Blasting has a direct negative impact of temporary duration on fish. The extent of the impact is regional, and limited to a radius of approximately 5 km from the pipeline. The amount of blasting in Estonian waters is probably limited, and it is possible that blasting will be substituted by dredging or subsea rock installation (*Ramboll 2014a*), which generates less noise. Blasting would not take place near the spawning areas. Therefore, the impact of impulsive noise on fish during the construction phase is assessed as moderate, considering the application of mitigating measures.

Continuous noise caused by construction activities also has a direct negative impact on fish. The extent of the impact is regional, and limited to the vicinity of the pipeline. The duration of the impact is temporary because construction activities are constantly moving along the pipeline (4–5 km/day). Therefore the impact on fish fauna is assessed as low, taking into account the application of mitigating measures.

In conclusion, on an individual level the impact of the noise can be irreversible if a fish is injured or killed. However, on a population level the impact is reversible and ends with the completion of construction work. Based on this, the impact of noise caused by the construction of the Balticconnector pipeline is estimated to be moderate and reversible.

6.5.5.1.2 Increase in the concentration of sediments in the water column

As a result of the seabed intervention (*Ramboll 2014a*) activities, the concentration of sediments in the water column will increase, which in turn may have a negative impact on fish fauna. An increased amount of sediments in the water column can injure fish physically – pelagic species are at the highest risk. Sediments can clog gills, which in turn blocks oxygen and the fish cannot breathe. Coarse particles can damage fish by abrasion of the body surface, which makes the fish more receptive to parasites and diseases. Cloudy water reduces vision, which disturbs predators hunting for prey. Sediments from the seabed will settle in another location, which can in turn impact fish like ammodytes, European flounder and turbot which are active on the seabed, and known to inhabit Lahepere Bay. In the worst case scenario, the increase in the concentration of sediments will cause death among fish. Newcombe and MacDonald (1991) found that juvenile salmon can perish if they come into contact for four days with sediment with a concentration of 1 – 49 g/l, (*Newcombe, 1991*).

Sensitivity to resuspended sediments varies between species and age, depending on gill size as well as on physiology and behavioral characteristics (*TÜ Eesti Mereinstituut, 2008*). Of fish active on the seabed, those most affected are the great and lesser sand eel (*Hyperoplus lanceolatus* and *Ammodytes tobianus*), which avoid seabed areas with oft sediment (clay, mud) (*TÜ Eesti Mereinstituut, 2008*). Of pelagic species, the most sensitive include Baltic herring, whose gills are adapted for catching small objects and therefore clog easily. The impact also depends on the size and density of particles, as well as on other characteristics. The general rule is that the higher the levels of re-suspended sediment in the water column, the greater the impact on fish fauna.

The impact of re-suspended sediment is the greatest on pelagic fish egg. Sediments tend to adhere to the eggs, making them heavier and causing them to sink to the seabed, where they perish (*TÜ Eesti Mereinstituut, 2008*). The fish spawning in Lahepere Bay attach their eggs to plants or rocks, and flatfish spawns under rocks; the re-suspended sediment does not endanger the eggs in Lahepere Bay significantly, but a negative impact cannot be totally excluded.

Fish larvae are sensitive to re-suspended sediments, and a high concentration of re-suspended particles in the water column can cause injury and death. After the spawning season, Lahepere Bay is an important feeding and recovery area for brit, and during that period it is recommended to avoid seabed activity that causes sediments to disperse.

Heightened concentration of sediments in the water column can cause juvenile and adult fish to avoid the area, but intensive contact can also be fatal. In general, concentrations resulting in avoidance should be on the scale of milligram per liter; for fatal consequences on the scale of gram per liter (*TÜ Eesti Mereinstituut 2008 and Wildish, 1985*). Avoidance can be caused already by a sediment concentration of 3 mg/l, (*Johnston 1985; Newcombe, 1992; Wildish, 1985 and Westerberg, 1996*).

The potential concentration of sediments in the water column was calculated for different parts of the pipeline during pre-lay, construction and post-lay activities. According to the results, sediment concentrations are higher in the deep open-sea areas, where fine sediments prevail and can remain in the water column for 5 days. Lahepere Bay mostly has coarse sediments, which settle relatively fast and in close vicinity (concentration ca. 10 g/m3 or 0.01 g/l) up to 2 km for about 2–5 days (see section 6.5.2). The concentrations are estimated to remain below the fatal limit, but may disturb fish and cause avoidance. During sediment modeling of Balticconnector construction activities, it was calculated that the sediments would rise up to 5 m from the sea bottom during construction work (including blasting), so fish swimming higher in the water column will not be affected.

Modelling calculations indicate that the concentration of sediment in Lahepere Bay will increase for approximately 2–5 days – an approximate amount of parent material lifted up from the seabed to the water column can be as much as 3% (see section 6.5.2). It is estimated the most intensive sedimentation will take place in the range of 1 km from the working site (see section 6.5.2). Sediments will rise to a height of approximately 1–5 m during dredging and blasting. According to modeling results (see section 6.5.2), there are no foreseeable high concentrations of sediment in the water column in Lahepere Bay because the sediment there mainly consists of sand with a heavier fraction. In open sea areas where sediments contain more clay and mud (lighter texture, posing a higher risk for fish), the sediments will remain longer in the water column, but their concentration is generally low and they do not remain there for more than four days.

In conclusion, it can be said that the dispersion of sediments transferred to the water column during the construction of the Balticconnector gas pipeline is rather local, and its impact reversible. It is likely that many fish will temporarily leave the area and return when the water quality has improved. Due to the temporary and local nature of the impact, the negative impact of re-suspended sediment on fish in the project area is assessed as small and reversible. Good conditions in the area will be restored after work is completed.

6.5.5.1.3 Harmful substances

Seabed intervention activities during construction period of the Balticconnector gas pipeline can cause the re-suspension of harmful substances from the sediment into water column, which can in turn have a negative impact on fish fauna in the area. Toxic substances like heavy metals and dioxides can accumulate in fish and cause poisoning, physical deviations and death. Pollutants pose the greatest threat for fish eggs, which are rather static and cannot move away from the polluted area. Even small concentrations of toxic substances can increase fish egg mortality and impact the development of brit.

Lahepere Bay is an area where human activity has had a relatively small impact. The concentrations of heavy metals in the bottom sediments practically did not exceed the limit applicable for the elements studied (*TTÜ MSI 2013*). Only the concentrations of cobalt and nickel slightly exceeded the target values applicable for the elements studied, but remained significantly below the limit established for industrial areas. The concentrations of organotin compounds TBT and TPT were lower than the detection limit of 1 μm/kg at most stations (*TTÜ MSI 2013*). The substances exceeded the detection limit at only four deep stations (58–101 m), which were also the furthest from the coast (*TTÜ MSI 2013*). Dioxins and radionuclides were within the limits of average values or even lower in the Gulf of Finland. It is unlikely that the concentration of toxic substances would increase significantly during the construction work. The potential impact on fish and fish eggs is temporary, and these local changes are not significant on the population level.

As an increased concentration of toxic substances in the water column is unlikely, reversible and local, then the overall impact of harmful substances on the fish fauna of Lahepere Bay is assessed as insignificant.

6.5.5.1.4 Disturbance

In addition to the noise of the construction work, the fish fauna will also be disturbed by physical work conducted on the seabed, as well as by the movement of ships in the area. Work carried out on the seabed, like dredging, pipeline construction and subsea rock installation, mostly impact the fish in immediate vicinity. A small number of fish can potentially be injured or killed during the construction. Increased vessel traffic can cause a minor disturbance for species inhabiting the upper layer of water. Taking into account the temporary and local nature of the construction, as well as the fact that the disturbance caused by ships involved in construction cannot be differentiated from that of regular ships, the impact of disturbance on fish fauna in Lahepere Bay is assessed as insignificant.

6.5.5.1.5 Changes in the food basis

Fauna on the seabed will be affected mostly in a 5 m radius on either side of the pipeline due to the rock layer created (*Pöyry*). Benthos further away can also be damaged during the construction activities, but this impact is temporary and reversible. The population of seabed fauna will presumably recover after the work has been completed. Taking into account the fact that fish fauna near the pipeline will be less numerous during the construction work, the impact of changes in the food basis on the fish fauna is assessed as insignificant.

6.5.5.1.6 Testing the pipeline

During the pre-commissioning phase, the pipeline will be tested using a pressure test. For that purpose, the pipeline is cleaned with seawater from which oxygen has been separated, and this water may contain additional biocides (glutaraldehyde or sodium hydroxide) in order to remove organic substances inside the pipeline (*Ramboll 2014a*). The cleaning water will be released into the sea, where, if it contains biocides, the cleaning water can have a negative impact on water quality as well as on nearby fish.

Water with biocides released from the pipeline will not spread extensively, and will be diluted rapidly when mixed with seawater (*Ramboll 2014a*). There are no foreseeable concentrations of biocides endangering fish in the area, and therefore the impact of pipeline testing on the fish of Lahepere Bay is assessed as insignificant.

6.5.5.2 Offshore area of the Gulf of Finland

Fish fauna

In the overall examination of the mechanisms impacting fish, the factor assessed as the most significant in the offshore area was the noise caused by blasting and other marine works. Other impacts include turbidity and increased sedimentation caused by marine works as well as habitat destruction in the seabed intervention area. Indirect impacts on fish may also occur via food sources.

The significant species of fish for the offshore ecosystem are Baltic herring and sprat. Both are pelagic species, i.e. schooling fish found in the open water column. Mostly mature individuals as well as juvenile age groups of these species are found in the offshore areas of the Gulf of Finland. Baltic herrings spawn on littoral vegetation in the archipelago zone, from where the young move close to the coast to grow. Sprat, on the other hand, mainly spawn in the main basin of the Baltic Sea. Therefore marine works carried out in the offshore area will not have an impact on the production of young of sprat or Baltic herring

The suspended solids impact from offshore seabed intervention is estimated to be limited to near-bottom areas in the vicinity of the worksites. Considering the magnitude and brief duration of the suspended solids load, the adverse impact caused is estimated to be low.

Underwater explosions are critical to mature pelagic fish in the zone where the pressure wave will cause physiological damage or even death. In practice the impact on the fish stock of a shoal of fish destroyed by a pressure wave is comparable with the catch from one trawl carried out by a fishing vessel. The occurrence of fish too close to a blasting site can be prevented using several methods. The noise caused by explosions has a deterring effect that changes fish behavior further away over a distance of several kilometers. The deterring of fish from the area will, however, be temporary.

Demersal fish found in offshore areas and their rate of occurrence in deep bottoms are insufficiently known as they are of no economic significance, excluding cod and flounder. It can, however, be said that there are no significant amounts of demersal fish nursery grounds at depths exceeding 20 m in the offshore zone of the project. Therefore any impacts will be targeted at mature and juvenile fish.

The behavior of demersal fish in conjunction with underwater blasting is more problematic than that of pelagic schooling fish. Demersal fish typically seek shelter on the bottom in locations such as by rocks, which is why they may remain in the project area despite efforts to deter them. On the other hand, demersal fish are not as sensitive to the impacts of underwater noise and pressure waves as they may be protected by seabed topography and many have a weak auditory sense (no swim bladder).

Seabed intervention destroys demersal fish habitats and feeding grounds. Areas to undergo intervention are found over a distance of tens of kilometers. On the other hand, these areas are narrow (tens of meters wide), whereby only a small amount of local seabed destruction will take place. In addition, the seabed intervention area will be replaced with coarse rock material which is likely to serve as a demersal fish habitat and feeding ground in the future. It is possible that certain species of fish will even favor these rock-filled areas. The impact on demersal fish on the whole is estimated to be low.

Migratory fish (mainly salmon and brown trout) found in the offshore areas of the Gulf of Finland are primarily there for feeding and, in the spring and summer, also for their migration towards rivers where spawning and nursing takes place. Salmon and brown trout smolts remain close to the shore, so any impacts are mainly targeted at mature fish. The impacts can be regarded to be similar to those on pelagic schooling fish.

6.5.5.3 Impact of operation and maintenance

The impact of operation and maintenance on the fish fauna is very limited if compared to the construction phase. The activities with the biggest impact in this phase are the physical existence of the pipeline on the seabed, disturbance and noise due to the movement of gas and pipeline repair as well as ship traffic due to pipeline maintenance.

There will be no significant impacts from the operation of the gas pipeline on fish in the offshore area. For example, the underwater sounds arising from operation are estimated to be insignificant in relation to the ambient noise level in the project area (*Klauson 2014*).

The rock dumping taking place to protect the gas pipeline may in soft-bottom areas create new utilizable habitats for demersal fish. On the other hand, in accumulation bottoms these rock beds will be quite rapidly buried in fine-grain material due to sedimentation and resuspension. Changes in the seabed along the gas pipeline route may be of minor advantage to some demersal fish.

In the event of a leak, natural gas will not mix with seawater. Instead, it will vaporize immediately and evaporate into the air. In repair situations short-term disruptions may occur locally.

6.5.5.3.1 Physical changes on the seabed

The pipeline laid on the seabed and partially covered with rocks is a new artificial construction on the seabed. Earlier, a number of post-observations have noted an increase in the populations of seabed fauna and fish in the area of offshore wind farms, where the turbine foundations have functioned as an additional habitat for certain species (*Wilhelmsson 2006; Reubens 2013* and *Bergström 2013*). The gas pipeline can similarly be an additional habitat for some species. For example, rocks and other hard substances are suitable for the blue mussel (*Mytilus edulis*) because it needs a place to attach itself. Abundance of fish can increase near the section of the pipeline covered with rocks, as this will provide diverse feeding and hiding opportunities for juvenile as well as adult fish. Research shows that this kind of habitat is suitable for fish like cod, eel, sculpin (*Bergström 2013*). This is a positive as well as negative impact on fish fauna. On the one hand, there is an additional habitat type, but on the other, the aggregation of fish in the pipeline area can cause more intensive fishing, which in turn may affect the number of some species. If there is an increase in the number of fish near the pipeline, this can be regarded as a small positive and insignificant negative impact. Altogether this effect can be regarded as insignificant

The changed seabed along the pipeline route can have a negative impact on spawning grounds. The most important fish spawning in Lahepere Bay is the Baltic herring, which requires the presence of certain macroalgae (*F.lumbricalis*, *C.tenuicorne*, *P.fucoides* and *P.littoralis*) and plants (*Z.marina*). Based on the distribution of these species in Lahepere Bay, a smaller impact would be ensured by alternative ALT EST 1, which goes through an area where the number of species is lower, than the route of alternative ALT EST 2. In general, the area of the planned gas pipeline is small when compared to the area of the bay, and it is probable that the impact caused by changes on the seabed on the spawning areas of Baltic herring as well as other fish is insignificant for both alternatives.

6.5.5.3.2 Noise

Gas will move through the operational pipeline, which causes little noise compared to the construction phase. In the case of Nord Stream, the noise generated during the operational phase remains between approximate frequencies of 0.030 and 0.100 kHz (*Nord Stream, 2009*). Since the Balticconnector pipeline will be smaller, operational phase noise is estimated to be even smaller. The lowest frequency range audible for a number of fish species is 0.030 and 0.100 kHz (*Martec Limited 2004*). The noise of the gas flow can exceed the background noise by max 10 25 dB at certain frequencies. Many species will not sense this due to their limited hearing ability. Cod and Baltic herring may be able to hear the sound of gas flow, but they will adapt to it in time (*Nord Stream 2009*).

Therefore the impact of gas flow noise during pipeline operation is assessed as insignificant.

6.5.5.3.3 Disturbance

Repairs and maintenance carried out to the pipeline, as well as vessel traffic in the area can disturb and deter nearby fish. However, this is a rare disturbance as the pipeline is maintained and repaired as needed.

Therefore, the impact of pipeline maintenance on the fish fauna of Lahepere Bay is assessed as insignificant.

Summary of the significance of the impacts

In conclusion, the impact of noise generated due to construction work can be assessed as moderate to small, depending on the amount of blasting involved. At an individual level, the impact can be irreversible if a fish is injured or killed. However, at a population level, the impact is reversible, and ends with the completion of construction work. Taking into account the fact that fish fauna near the pipeline will be low during the construction work, the impact of changes in the food basis on the fish fauna is assessed as insignificant. The impact of pipeline maintenance on the fish fauna of Lahepere Bay is assessed as insignificant.

Table 6-7. Impact significance on fish fauna. C = construction phase, O = operating and maintenance

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	**O** **No impact**	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	**C** **Moderate**	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.6 Impact on marine birds

The possible impacts of the project's activities on marine birds at Lahepere bay are assessed as follows:

Construction – seabed work that produces re-suspension of sediments and toxic substances into the water column, noise and vibration, destruction and altering of the dynamics of the food supply of the seabed biota and birds, and disturbance of birds.

Usage – operation and maintenance, vessel traffic in the sea related to pipeline repair and maintenance work that will entail disturbances, risk of oil spills, noise and vibration, and in the case of major repair work, also re-suspension of sediments into the water column.

6.5.6.1 Impact of construction activities

During construction activities, work is carried out that will have a negative impact on shorebirds and marine birds staying and feeding in the project area. Above-water noise due to construction activities and visual disturbance of birds will produce the most significant impacts. Construction of the Balticconnector gas pipeline is estimated to last two years, of which the main construction activities will take approximately one year. During this period the impacts will be substantially more intensive.

Ice conditions permitting, a certain amount of birds are found in the offshore areas of the Gulf of Finland around the year: Anseriformes, Gaviiformes, cormorants, gulls, terns and Alcidae, with seals and occasionally also harbor porpoises also found. No particularly important feeding areas attracting large numbers of individuals are known in the area covered by the natural gas pipeline project. Among the groups of birds mentioned above, Anseriformes in particular feed in shallow areas very rarely found in open sea areas. Adverse impact on animals can be reduced by observing the species during construction and using mitigation methods during work stages that cause the highest levels of underwater noise.

Turbidity resulting from seabed intervention may temporarily affect food sourcing among aquatic birds in the area where turbidity occurs and affect the occurrence of their diet organisms, such as fish and bivalves, in the vicinity of the pipeline. Sediments settling on the bottom may cover blue mussel (*Mytilus edulis)* communities from which in Eider in particular and during migration/winter also Long-tailed Duck source their food. Fish and small aquatic organisms belong to the diet of birds including the White-tailed Eagle (*Haliaeetus albicilla)* and Osprey (*Pandion haliaetus)*, waders, gulls, terns and Alcidae. During the nesting period in particular the need for food is high as the mothers need to stay in good condition and feeding the young further increases the need for food. The impacts of increased turbidity on fish stocks and other aspects of the marine environment in the offshore areas of the Gulf of Finland are estimated to be low as the turbidity is estimated to be restricted to areas in the vicinity of the pipeline and near the bottom and only occur for a few days. The impacts of offshore turbidity on bird fauna are also likely to be low as the impacts on fish, bivalves and other small fauna that they feed on are estimated to be very local and short-term.

6.5.6.1.1 Sediments and pollutants in the water column

During seabed work (dredging, blasting, dumping, laying the pipeline and covering it with rocks) an additional amount of suspended material will rise into the water column and additionally pollutants may be released from the sediments.

Suspended materials that have risen into the water column may have a direct and negative impact on species which feed by diving, and which use visual detection of prey items. These species include Grebes, Divers, Cormorant, Diving Ducks from the family of *Anatidae*, Black Guillemot and Razorbill. Also seagulls and terns catching prey from the top layer of the water column can be affected. The increased concentration of suspended materials in water may decrease the visibility radius of diving birds, and thus influence their ability to capture prey. During some critical periods like winter and nesting time, fast, efficient food capture is vital for birds. A critical concentration of 15 mg/l of suspended materials is considered as forming the start of negative impacts (*Nord Stream 2009*). However, studies have found that in addition to vision, birds can also use other senses to capture their prey. This is indicated by the fact that Cormorants and several other species are also able to dive for their catch in the darkness of night (*Strod 2004*).

During Balticconnector pipeline construction works integrated amount of suspended matter over 10 g/m2 will be thrown up and extended further than 1 km from the work site. Sediment material will be thrown up to a height of 5 m into the water column, and will settle within an average of 2–5 days depending on wind strength. Load settling is the greatest in a radius of 1–2 km from the point of dumping, ensuing that the sediments will not spread much. In the open sea, concentrations will most probably be greater because the proportion of clay in the sediments there is higher. Due to the great depths involved, however, there are no important feeding areas for birds (see section 5.1.11.2). In Lahepere Bay, most of the sediments consist of sand of large fraction that settles fast. Mud and clay that remain longer in the water column are scarce in the sediments of Lahepere Bay and willprobably not significantly reduce underwater visibility (section 6.5.2). nevertheless, it is advisable to avoid construction work during the nesting and wintering period of birds (especially Black Guillemot and Long-tailed Duck), when even a slight change in environmental conditions may reduce nesting and feeding success.

During construction work on the Balticconnector gas pipeline, no great or long-term suspension concentrations in the water are foreseen, and its impact is considered to be altogether insignificant.

Together with sediments, also pollutants found in sediments, e.g. heavy metals, dioxins, radionuclides and organotin compounds can be thrown in the water during the seabed work. Toxic substances may accumulate in fish and the tissues of seabed fauna, and thus end up in birds feeding on them. However, Lahepere Bay is a location of little human activity. Preliminary studies show the concentration of toxic substances in sedimentsin the bay to be small (*TTÜ MSI 2013*). Consequently, no harmful concentrations for the biota, including birds, are foreseen, and the impact of pollutants is also considered/regarded as insignificant.

6.5.6.1.2 Noise and visual disturbance

Construction work on the Balticconnector gas pipeline will produce noise and vibration above the natural levels. This will have a direct negative impact on the birds feeding in the area. Construction work will generate noise both above and below water. Underwater noise can in turn be divided into impulsive noise that is generated during blasting, and continuous noise that is generated during construction and seabed work, e.g. dredging, piling rocks, etc. Above-water noise is mainly generated by vessel traffic related to pipeline work in the area, and also construction work while building the landfall sites. Underwater, the noise from seabed work and blasting is additional.

In the case of above-water noise, it is difficult to distinguish the impacts of noise and visual disturbance, because noise will be generated by vessels involved in pipeline work. Such noise will scare away the birds and also constitute a visual disturbance. Different species have different sensitivity to noise and visual disturbances. Bird groups generally more sensitive to noise and visual disturbances are Divers, Scoters, Goldeneyes, Eiders and, according to observations, also Long-tailed Ducks (*Pettersson 2005 and Furness 2013*). Disturbances can cause different reactions in birds causing then to startle, cock their heads in caution, flying further away or leave the area altogether (*Ecology Consulting 2001*).

When noticing a moving vessel or hearing noise, disturbed birds often fly further away. According to different studies, they may fly ~200 m away, depending on species. The usual disturbance distance is 1–2 km from the vessel in the case of more sensitive species like Divers and Scoters, and slightly less in the case of Cormorants. Terns and Gulls are less sensitive to disturbance (*Borgmann 2011*). Return of the birds depends on several factors like the presence of a nest in the proximity, abundance of food, season and the duration of disturbance (*Borgmann 2011*). The longer the visual and noise disturbance, the more likely the number of birds in the area will decrease. In the case of this project, it is probable that birds will gather further away from the pipeline route during construction work, and then return once the disturbance has ended/moved further away along the route.

There are practically no studies on the hearing of birds underwater. In humans, hearing ability decreases underwater (2 kHz→800 Hz). A similar principle probably also applies to birds. It is quite probable that while diving, a bird's ears will "close" both to prevent water from entering and to balance pressure (*Dooling, 2012 and Popper, 2012*). Hearing underwater is therefore probably not an essential function for birds. However, it cannot be ruled out that birds would be disturbed by sounds louder than background noise.

The highest sound pressure levels are generated during blasting (sound intensity is 201–205 dB at source), which is planned at a distance of 25–30 km from the shore at depths of ca. 50 m in Estonian waters. There are no significant feeding areas of Diving Ducks in this area – only small numbers of Long-tailed Ducks have been observed in the deep open sea area.

However, there are important feeding and resting areas for several seabirds, both breeding and migratory species (Long-tailed Duck, Black and Velvet Scoter, Goldeneye, European Herring Gull), closer to the coast and in Lahepere Bay (see section 5.1.11.2). Continuous noise levels during construction (dredging, pipeline laying, rock dumping, vessel movement) are lower than blasting (sound intensity is estimated to be 195 dB at source), but the noise is constant and significantly exceeds background levels (estimated to be 65 dB). It is probable that due to disturbance, the number of birds feeding and resting in the water will small in the pipeline area during the construction phase and will recover after construction has been completed.

In conclusion, the impact of noise and visual disturbance on birds is direct and negative, but due to its short duration it is evaluated to be moderate. As a mitigation measure it is necessary to avoid carrying out works during the nesting period from the beginning of April until the end of July (see chapter 9) and in shallow coastal zone during the wintering period of long-tailed ducks and other species from October 1st till January 31st (see chapter 9), when the noise and disturbances generated by the works may have a negative impact on the species nesting and wintering on Lahepere bay. Special care should be taken in regard to black guillemots who's only known nesting place in Estonia is situated at the northern and northeastern shore of Pakri peninsula. About 10–20 pairs of black guillemots are estimated to nest in the area (see chapter 5.1.11.2).

6.5.6.1.3 Changes in food supply dynamics

Construction of the pipeline on the seabed will destroy seabed fauna over a radius of approximately 10 m. This will impact diving birds feeding on benthos. The most numerous, and most impoartant species from the conservation aspect in Estonia, and in some cases in the EU, are the Long-tailed Duck, Black Guillemot, Goldeneye, Common Scoter, Black Scoter and Common Merganser. Destruction of benthos along the pipeline route is reversible and most of the seabed fauna will recover once construction has been completed. It is possible that once construction work as been completed, the numbers of seabed fauna will increase because the pipeline will create an artificial structure that some species, e.g. blue mussel, can attach themselves to (*Ecology Consulting 2001*). Thus there may be a positive impact on birds due to the increase in food supply. Construction-related disturbances, especially noise, will also have a negative impact on the fish in the area. Fish can become less numerous during the construction work and this may affect fish-eating birds, e.g. Laridae, Divers, Cormorant, Grebes. Like the benthos, the fish will recover once construction work on the pipeline as been completed and will be able to gather around the pipeline.

As the impact of construction works on the benthos and fish is moderate and reversible, the indirect impact on the avifauna is considered to be minor and reversible. Nevertheless, it is advisable to avoid construction works in Lahepere bay during the nesting period of birds from the beginning of April until the end of July, when even minor disturbances can have an important negative impact on nesting success.

6.5.6.2 Impact of operation and maintenance

During operation of the pipeline, the impact on avifauna will be minor. The most significant impact will be vessel traffic related to pipeline maintenance work in the area. This will generate noise, visual disturbance and increase the risk of oil spills in the area.

6.5.6.2.1 Noise, vibration and visual disturbance

In conjunction with pipeline operation, vessel traffic will increase in the area. This can scare away the birds feeding and staying nearby (see section 6.5.6 for a more specific description of bird behavior). Pipeline maintenance and repair work will only take place when needed, and since the associated vessel traffic is most likely to be sparse, the impact will be indiscernible from regular vessel traffic (e.g. fishing vessels). Consequently, the impact of noise and disturbances on the birds in the area due to pipeline operation is regarded as insignificant.

6.5.6.2.2 Risk of oil spills

Vessel traffic associated with the pipeline will add to the regular vessel traffic, which is very small, at Lahepere Bay. Increased traffic in turn will result in the increased probability of oil spills that would mostly affect the birds staying and feeding at sea, and less those nesting and feeding on islets and on the shore. The most threatened are birds feeding in water, e.g. waterfowl, White-tailed Eagle, Waders, Gulls, Terns and auks, which will be most exposed to the harmful substance in the case of an accident.

Spills of oil products into the sea are more dangerous during the winter half-year, when temperatures are low and the evaporation of oil products from the surface is slow. Birds contaminated with oil become hypothermal, and will die quickly in the winter cold(*Kuris 2009*). In addition to hypothermia, another negative effect is the accumulation of toxins in the organism that can become a danger (among other species) for the White-tailed Eagle (*Haliaetus albicilla*), a rare species in Estonia, feeding on fish and other birds.

Considering the ad hoc vessel traffic in conjunction with pipeline maintenance, which is most probably rare, the risk of oil spills in Lahepere Bay will not increase significantly, and all in all its impact is regarded as insignificant.

Summary of the significance of the impacts

The impact of noise and visual disturbance on birds is direct, negative and intensive, but due to its short duration it is regarded as moderate. Since the impact of construction work on the benthos and fish is moderate and reversible, the indirect impact on the avifauna is regarded as minor and reversible.

Table 6-8. Impact significance on marine birds. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	**O** **No impact**	Low	Low	Moderate	High
	Moderate	High	High	**C** **Moderate**	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.7 Impact on marine mammals

The following is an assessment of the impact of construction and operation of the Balticconnector gas pipeline on the grey seal, the only marine mammal present in the project area in larger numbers. Gray seal can be encountered in Lahepere Bay during its calving period, as well as at other times. The gray seal is in wildlife protection category II and in Habitats Directive Appendix II and IV. The main activities that may negatively affect gray seals are related to construction work. During operation no significant negative impact is to be foreseen for seals.

Both, construction and operational phase impacts also affect the ringed seal and harbor porpoise. However, since the ringed seal and harbor porpoise seldom occur in the region, the project impacts on these species are considered insignificant as a whole.

6.5.7.1 Impact of construction activities

Construction work can involve negative impacts for the gray seal – noise and vibration, sediment and pollutant release into the water column, the breaking of ice. Noise and vibration generated by construction will probably have the biggest impact on seals.

Increased turbidity affects marine mammals in the same way as birds: it may have a temporary adverse impact on their feeding by deterring fish and reducing visibility. The impacts of turbidity on fish stocks and other aspects of the marine environment in the offshore areas of the Gulf of Finland are estimated to be low, whereby the impacts on marine mammals are also likely to be low. In addition, marine mammals are only found infrequently, either individually or at most in small groups, in the area affected by the project.

6.5.7.1.1 Noise and vibration

Noise generated during construction work can be divided into impulsive noise that is generated during blasting work, and continuous noise that is generated during other construction work, e.g. dredging, laying the pipeline on the seabed, piling rocks, construction at the landfall site, etc. The sound generated during this work is considerably louder than natural background noise (65 dB), and it is at least partly audible to the gray seal. The highest levels of sound pressure will be generated during the small quantity of blasting carried out in Estonian waters and far from the shore. The shockwave generated by blasting is most dangerous for seals. Seabed work and pipeline construction will generate constant noise of lower intensity, but it represents a continuous disturbance.

The seals in Lahepere Bay are most the influenced by underwater noise, which is considerably higher than above-water noise during the construction phase. Since seals use signals propagating over comparatively long distances for communicating underwater, increased noise levels can lead to situations where they can no longer hear the communication signals of their congeners. The noise can produce behavioral changes like fleeing and decreased ability to capture prey. The impact of noise that causes masking and behavioral changes for seals is nevertheless insignificant and reversible, since it will only last during the construction phase (*Thomsen 2006*).

High sound pressure levels during blasting may cause injuries and the deterioration (both temporary and permanent) of hearing. This is a serious impact at the individual level, and in the case of a larger number of individuals affected it can also be noticeable at the population level. A temporary change in the hearing thresholds of seals can form at an estimated 763 m from the blasting point, permanent change or hearing damage can form at up to 100 m. "The safe distance", at which presumably no hearing-related changes are caused, is 3–5 km. This is also the radius of the serious impact area in the case of blasting (Table 6-9). Table 6-10 lists the "safe distance" in the case of permanent noise from which marine mammals do not form a temporary change of hearing threshold – it is ca. 26–51 m.

Table 6-9. Blasting safe distances according to the thresholds for Behaviour Disturbance Threshold (BDT), Temporary Threshold Shift (TTS), and Permanent Threshold Shift (PTS) (*Klauson 2014*).

Marine mammals (Grey Seal) weighted SL=220dB (confined) and SL=230dB (unconfined)				
Threshold	Distance, m	Uncertainty, m	Distance, m	Uncertainty, m
BDT (not defined)	-	-	-	-
TTS (171 dB)	763	1000	3000	5000
PTS (186 dB)	100	100	380	500

Table 6-10. Pipelaying safe distances from the pipeline route according to the thresholds for Behaviour Disturbance Threshold (BDT), Temporary Threshold Shift (TTS), and Permanent Threshold Shift (PTS) (*Klauson 2014*).

Marine mammals (Gray seal)		
Threshold	Distance, m	Uncertainty, m
BDT (not def.)	-	-
TTS (171 dB)	26	25
PTS (186 dB)	-	-

In addition to construction work and blasting, noise is also generated by vessels related to construction work (185190 dB). In comparison to the rest of construction work, vesselnoise is minor and can cause temporary changes in the hearing threshold only when a specimen is in the immediate vicinity of the vessel. Vessel noise can also shield the communication signals of seals (*Thomsen 2006*). Since construction-related vessel traffic is temporary, it does not have any significant long-term impact on the seals in the region.

It is likely that individuals will retire to a safe distance from construction and vessel noise (from an estimated 400 m to 5 km and more). Therefore, constant construction and vessel noise does not represent a significant danger for gray seals. However, it must be taken into account that during the calving season, from February to March, individuals with pups are sedentary, and comparatively sensitive to disturbances (*Thomsen 2006*). Since Lahepere Bay is not known to be an important calving area for gray seals, the negative impact of noise from construction work on the species in Lahepere Bay and its nearest environment is considered to be moderate and temporary. As a mitigation measure, it is advisable to use so-called warning sounds at blasting points to scare away the seals in the area before major blasting.

6.5.7.1.2 Re-suspension of suspended particulates into the water column

During the construction work of the Balticconnector pipeline, a higher than natural level of concentration of seabed sediments will be thrown into the water column. The increase in suspended particulates in the water is a temporary phenomenon. The settling rate depends on the fraction of the particulates – in Lahepere Bay the suspension matter will remain in the water column for a shorter time than in the open sea because most of the sediment is comprised of sand that will settle within a few days. Also in the open sea, the settling rate is estimated to be a maximum of 5-7 days (see section 6.5.2), which is a short time. Settling peaks are highest at 1 km from the work area.

As seals are very mobile animals, covering large distances in search of food, the temporary increase in suspension matter in relation to work on the pipeline will have no significant impact on them. Water turbidity and the ensuing decrease in visibility does not influence seals when preying, because in addition to vision, also hearing is important and often even more so than vision (*http://www.seals-world.com*). Water turbidity can be accompanied by a temporary decrease in the amount of fish in the area, which has an insignificant impact on seals because they can cover great distances in search of food. Taking into account the fact that the increased concentration of sediments will only last for a short time, around 4-5 days, in many places even less, the fish will probably return after the water quality has recovered.

Taking into account the short duration and local nature of increased concentrations of suspension matter, its impact on seals is regarded as insignificant.

6.5.7.1.3 Release of pollutants

Seabed work and blasting can cause the re-suspension of pollutants from sediments into the water column. In concentrations higher than the natural level, these can end up in marine organisms. Most endangered are the top links in the food chain, incl. seals, which feed on other organisms and can thus accumulate toxic substances. Heavy metals are especially dangerous.

Lahepere Bay is an area of comparatively minor human activity, and its sediments did not show high concentrations of toxic substances during the preliminary study (*TTÜ Meresüsteemide Instituut 2013*). Heavy metal concentrations mostly remained below valid criteria. Concentrations of organotin compounds TBT and TPT remained below the detection limit at most stations. Dioxins and radionuclides corresponded approximately to the average values in the Gulf of Finland or were lower.

Taking this in account, s it can be concluded that the concentrations of toxic substances lifted into the water column from sediments are insignificant, and remain in the water column for a short time during construction work. It is very likely that during this period the seals will avoid the area close to construction work due to other disturbances. Consequently, the impact of pollutants on the gray seal is regarded as insignificant.

6.5.7.1.4 Disturbance during the calving period

The gray seal prefers to calve on sea ice, and is comparatively dependent on ice conditions during the early spring calving period (end of February – beginning of March). Gray seals are also known to calve in the project area, although there are no data on the numbers of calving seals (see section 5.1.12).

On the coast of Pakri Peninsula and in Lahepere Bay, the duration of ice cover is regarded to be 26–48 days (see section 5.1.6). It is therefore possible that construction work will be carried out during the ice period and that an ice-free corridor will be created for construction-related vessels. Ice-breaking and the disturbances and noise related to it can have a negative impact on seals calving nearby. Ice broken by ship traffic is unstable and can affect calving conditions for seals that remain close to the area. The disturbance may cause behavioral changes in calving seals that may lead to a higher mortality rate of pups (*Thomsen 2006*).

Taking into account the lack of data concerning the number of calving individuals in Lahepere Bay, it can be assumed that this area is probably not of key importance. Consequently, the impact of construction work in early spring (ice-breaking, disturbance, noise) on calving seals is regarded as low and temporary.

6.5.7.2 Impact of operation and maintenance

The impact of gas pipeline operation and maintenance on seals is very low in comparison to the impact during construction. The main disturbance is vessel traffic related to pipeline maintenance in the area. This which causes visual and noise disturbance, as well as splitting the ice in the potential calving area of the grey seal.

6.5.7.2.1 Vessels related to pipeline maintenance

Since Lahepere Bay has been a region of comparatively low vessel traffic, it can be assumed that the increase in vessel traffic related to pipeline maintenance and repairs in the area may disturb gray seals (*Thomsen 2006*). Taking into account the fact that the pipeline is maintained and repaired only when needed, and most probably infrequently, the impact of vessel traffic on gray seals in Lahepere Bay is regarded as insignificant. Caution is only required during the early spring calving period of seals, when it is advisable to avoid maintenance work. Where this is impossible, lower vessel speeds should be used when moving in the bay.

Summary of the significance of the impacts

Since Lahepere bay is not known to be an important calving area for grey seals, the negative impact of noise on the species from construction work in Lahepere bay and its nearest environment is regard as low and temporary.

Table 6-11. Impact significance on marine mammals. C = construction phase, O = operating and maintenance, L = Lahepere Bay.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	**C/ L** **Low**	**O** **No impact**	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.8 Impact on protected natural objects

Impact on Pakri Limited Conservation Area (LCA) (KLO2000167)

Protected natural objects in the Pakri Limited Conservation Area are the same as in the Pakri habitats and birds directive sites. An assessment of the project's impact on protected natural objects is given in section 6.7 Natura assessment and is not repeated in this chapter.

6.5.9 Impact on the coast

Section 5.2.1 gives an overview of the coast and shore processes of Lahepere Bay. In accordance with the dynamic of shore sediments, the alongshore drift of the sediments in the bay is dominated by movement from the western and eastern shores of Lahepere Bay toward the top of the bay, where an eight kilometer long sandy shore has developed within the boundaries of an ancient buried valley located between small klint capes. The landfall sites of the natural gas pipeline are planned on the western shore of Lahepere Bay, with different sections of the Baltic klint as the main larger morphological features in the area.

The landfall site of the ALT EST 1 natural gas pipeline alternative is located in Kersalu, where the shore has temporary traces of abrasion and poorly formed accumulative ridges containing gravel, pebble and sand. The coastal sea bed is gently sloping and includes 23 sandbars. From this area towards the top of the bay, a transitional area begins from an erosion shore to an accretion shore.

The landfall site of the ALT EST 2 natural gas pipeline alternative is located at the southeast boundary of a small accumulative formation at the borderland of a small vestigial cape strewn with boulders elongated far into the sea, and the following erosion-accretion shore. The small cape is rich in boulders and prevents most of the gravel and pebbles from migrating further toward the southeast (top of the bay).

6.5.9.1 Impact of construction activities

In both landfall sites, it is planned to lay the gas pipeline in a trench in the seabed at a depth of up to 13 m and to backfill the trench to make it level with the seabed. The length of gas pipeline to be laid in the trench is 2 km in the case of ALT EST 1 and 1.5 km in the case of ALT EST 2.

Taking into account the fact that construction of the pipeline on the seabed will not create a piled-up ridge on the seabed at a depth of 0...-13 m, there will be no impact resulting from the structure on the development of the shores of Lahepere Bay as a whole, especially on the shore processes within the sandy beach during construction.

6.5.9.2 Impact of operation and maintenance

There will be no impact resulting from the structure on the development of the shores of Lahepere Bay as a whole, especially on the shore processes within the sandy beach during operation and maintenance.

Summary of the significance of the impacts

Taking into account the fact that construction of the pipeline on the seabed will not create a piled-up ridge on the seabed at a depth of 0...-13 m, there will be no impact resulting from the structure on the development of the shores of Lahepere Bay as a whole, especially on the shore processes within the sandy beach either during construction or during operation and maintenance.

Table 6-12. Impact significance on the shore.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	**No impact**	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

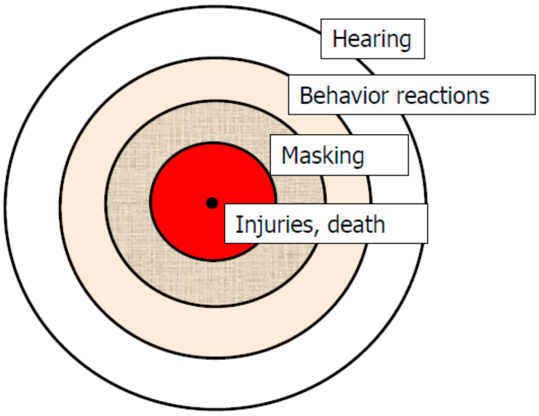
6.5.10 Noise

Underwater noise

Underwater noise calculations were carried throughout the pipeline route and for the different project alternatives. The sensitive areas (protected areas) located in the vicinity of the pipeline route and the impact of noise on them were taken into particular consideration in the noise calculations.

Pressure waves produced by underwater explosions travel in water in the same way as in the air. Pressure waves may damage nearby structures and have adverse impacts on people, fish and other animals in water, in the worst case killing them if too close to the site of explosion. The lethal range may be tens of meters, and serious impacts may be caused even further. Further away from the explosion site the pressure wave created will have a deterring impact on organisms such as fish.

Depending on the distance between source and receiver, four zones are used to estimate underwater noise impact on the marine organisms (Figure 6-19). These zones are: 1) hearing, 2) behaviour reactions, 3) masking and 4) Injuries and death. The dangerous zone corresponds to the area near the noise source where the received sound level is high enough to cause organism tissue damage resulting in either temporary threshold shift (TTS) or permanent threshold shift (PTS) or even more severe damage causing death.



By Richardson *et al.* 1995

Figure 6–19. Theoretical zones of noise influence on marine organisms *(Richardson 1995)*.

Sources of underwater noise during the project activities are seabed intervention (rock dumping, dredging and blasting), pipe-laying and trenching, landfall construction, pipeline inspection and maintenance and gas flow. The noisiest activities are seabed excavation (dredging or blasting), pipe-laying and trenching. These activities are included in the worst-case scenarios, which are expected to generate highest noise levels. Constructional phase worst-case scenarios:

- Blasting of bedrock peaks at pipeline route near Ingå
- Pipe-lay at pipeline route near Ingå
- Pipe-lay along pipeline route near Paldiski

A graph illustrating the sound source noise emission level for blasting work as a function of frequency is shown in the figure (Figure 6–20.).

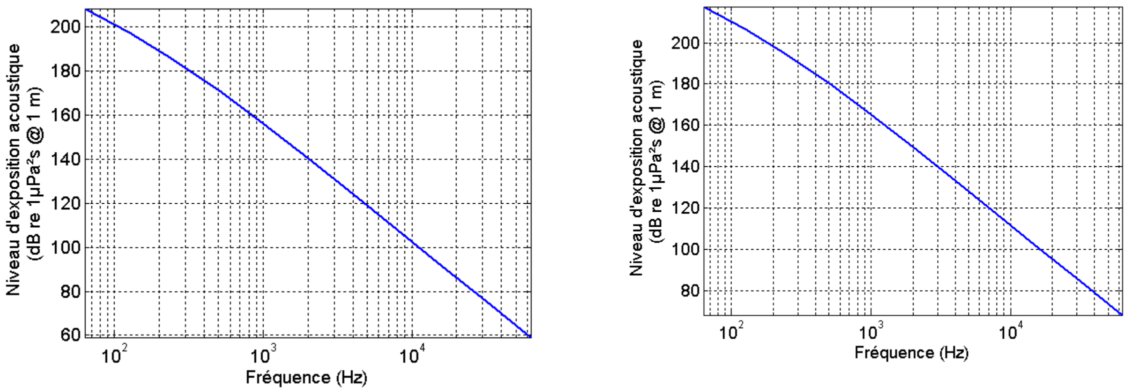


Figure 6–20. Model of source level from explosive blasting (acoustic component after conversion of the shock wave into an acoustic wave). Left: 1kg of equivalent TNT confined blast and duration of 3ms. Right: 1kg of equivalent TNT unconfined blast and duration of 3ms (*Santos et al. 2013*).

To protect mammals from the underwater blasting generated noise, the following relationship to calculate the safe distance had been suggested which originates from the U.S. Navy Diver Formula. The Navy Diver Formula is designed for unconfined charges and it is very conservative:

Dangerous zone radius (ft) = 520 $(\text{lbs/delay})^{1/3}$

A modern equation is proposed by Konya (Navigation Study, 2012). This formula agrees better with the measurements of pressures generated in the water from the underwater blasts with the explosives in boreholes. The general equation for predicting the distance at which the shock pressure in the water is 50 psi (0.34MPa) is:

Dangerous zone radius (ft) = 132 $(\text{lbs/delay})^{1/3}$

The source levels of the typical vessels involving in the pipe-lay are taken based on the data from previous similar projects for the construction of the North Stream and South Stream natural gas pipelines. Continuous noise, broadband SL (dB re 1 µPa at 1 m):

1.	Laybarge, pipe-laying	190 dB
2.	Anchor handling vessel	190 dB
3.	Supply boat	185 dB
4.	Dredging/trenching vessel	190 dB

Group of vessels 1–3 has equivalent source level (SL) of 194 dB re 1 µPa at 1 m.

The underwater noise propagation has a large amount of uncertainty. The conservative approach generally overestimates noise levels at large distances. Temperature gradients, bottom topography, and currents are noted to cause sound levels to attenuate more rapidly than expected from geometric spreading.

Uncertainties of the SPL assessment are linked to the following factors:

- Model of geometrical spreading used for this preliminary assessment is simplistic and do not take into account the effects of the marine environment;
- Variability of the ambient noise level which, at certain levels and/or ranges, may mask the noise of the construction work. The ambient noise level is depending on the already existing human activities in the area and the sea state;
- Seasonal changes of water column properties which influence largely the propagation of the noise introduced by the construction work. Temperature and salinity profiles of the sea vary in space (vertically and horizontally) and time (daily and seasonal trends). Sound waves are highly sensitive to stratification, and a negative vertical temperature gradient will result in the refraction of sound waves towards the seabed where they will be subject to the influence of sediment. Conversely, in the absence of stratification (homogeneous medium), sound can carry further because acoustic ray paths interact far less with the boundaries such as surface and seabed.
- Uncertain values of source levels of ships;
- Effect of bathymetry and sea bottom sediment composition to the sound propagation which influence largely the propagation of the noise introduced by the construction work. Sound-propagation losses are greater as water becomes shallower, a cumulative loss effect that derives from shoaling caused by changing bathymetry. The effect is linked to the interaction of sound waves with the interfaces of the sea waveguide (surface and seabed). Furthermore, it should be noted that sea waves tend to surge as they encounter shallower water, which increases their contribution to ambient noise.

6.5.10.1 Impact of construction activity

6.5.10.1.1 Above water noise

The above-water noise impacts concerning the pipeline route across the Gulf of Finland were not examined separately using noise modeling as the result is in the same range as the modelling results for Paldiski and Ingå (see Appendix 5), i.e. the 45 dB(A) zone may, according to the calculations, extend to around 500 m during the point of passing of the pipelaying vessel (LAeq, 15 h). The noise level is regarded as normal above-water shipping noise, with any noise pollution load occurring locally being very short-term in nature.

6.5.10.1.2 Underwater noise

Gulf of Finland

The propagation of underwater noise is affected by the underwater acoustics of the Baltic Sea. The Baltic Sea is relatively shallow, which results in some frequencies being filtered out. *(BIAS 2014)* The propagation of sound close to the shore differs from that in offshore areas. As well as depth, the propagation of sound in water is also affected by the salinity and temperature of water as well as the stratification of these, with sound attenuation caused by the gradients. The quality of the seabed also affects sound propagation as soft bottoms reduce sound reflection while hard rocky bottoms reflect sound, resulting in only minor propagation loss. *(Poikonen & Madekivi 2010)* For part of the year the Baltic Sea is covered by ice, and the ice cover may affect the underwater soundscape. There is, however, currently very little research data on these. *(BIAS 2014)*

According to the assessment calculations, the maximum level of underwater noise in the Gulf of Finland during the construction of the natural gas pipeline will be around 145 dB (re 1 μPa) at 1 km from the pipelaying vessel and at the closest point of approach (CPA) of the vessels (NLP, see Table 6-13.) around 155 dB (re 1 μPa) where the vessel is at the same point as the receiver. The level can be regarded as such that can be heard by many marine mammals, and it may also significantly mask other sounds. The sound level is high enough to be able to cause a temporary threshold shift (TTS) only within a few meters from the pipelaying vessels.

As regards noise, the impact assessment causing impacts on people is presented in section 6.6.4 and on fauna and protected sites in section 6.5.7.1.1.

Paldiski area

During constructional works of the Balticconnector natural gas pipeline the highest levels of the underwater noise in the sea originate from the supply vessels and various underwater engineering works such as dredging and blasting. There will be pre-lay preparation of the seabed along the pipeline route before pipeline installation can occur. Some of this pre-lay preparation works in the gulf offshore area will involve excavating peaks on the seabed. Excavation can be performed either by dredging or blasting, depending on the soil conditions and the environment.

The gas pipeline route is crossing the Pakri Natura 2000 area (yellow area in Figure 6-21) near the Estonian coast, and the underwater noise from the pipeline supply vessels and the underwater construction works can be audible for the marine mammals, fish and birds. The broad band Sound Pressure Level (SPL) is varying from 123 dB re 1µPa (alternatives ALT EST1 and ALT EST2) at the border of the protected area up to 195 dB re 1 µPa at the pipeline route. In a worst-case scenario, the ambient noise levels, which are depicted by the Wenz curves results for the moderate marine traffic (Table 6-13), can be exceeded by 58 dB up to 130 dB at the 1/3 Octave-band center frequencies (63 Hz and 125 Hz). These frequencies are suggested in Descriptor 11 (Noise/Energy) of the MSFD 2008/56/EC to use for estimation of the anthropogenic ambient continuous noise trends in the European Seas. Excavation works are not planned inside the the Pakri Natura 2000 area, and therefore at the pipeline route in the gulf offshore area, the received noise levels from blastings can be higher as compared to the pipelying noise from the supply vessels.

Under optimal conditions the pipelaying rate in the Gulf of Finland is 35 kilometres per day. During the construction phase the pipelaying fleet with Source Level (SL) 194 dB re 1 µPa at 1 meter is moving along the route, followed by the trenching vessel with SL = 190 dB re 1 µPa at 1 m. Estimating the Received Level (RL) away from the noise source, the Transmission Loss (TL) 17log10 (range in meters per 1 metre) was suggested for 1/3 Octave band spectra in the Baltic Sea near one of the main shipping lanes and the route of Nord Stream's second pipeline by FOI, Swedish Defence Research Agency. Noise Level Points (NLPs) are defined at the boarder of the Pakri Natura 2000 area (Figure 6-21.).

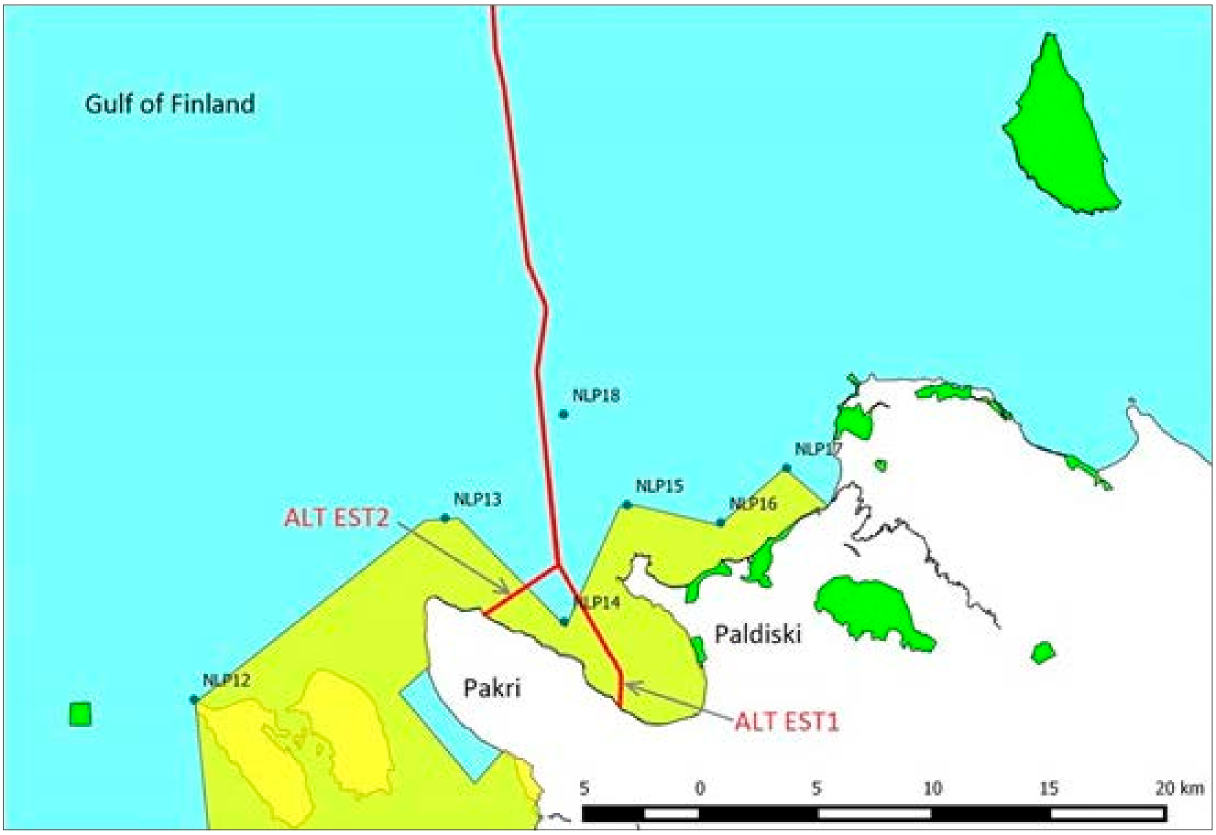


Figure 6-21. Two alternative ALT EST1 and ALT EST2 of the pipeline route near the Estonian coast of the Gulf of Finland are indicated by red lines. The noise levels are estimated at the points NLP12-NLP18. Conservation areas are shown by green areas and the Pakri Natura 2000 area is indicated by the transparent yellow area.

In Table 6–13 the underwater noise Received Levels during the pipelaying and trenching are estimated at the border of the protected area i.e. at NLP12 NLP17. An extra point NLP18 is located to the north of the Lahepere Bay in offshore area. The gas pipeline crosses the protected area, and the actual noise levels due to the pipelaying can be higher from the noise levels at NLP-s.

Table 6–13. Pipelaying noise Received Levels (dB re 1 µPa) at the visually closest point of approach of the vessels fleet moving along the two alternative pipeline routes near the Estonian coast of the Gulf of Finland.

ALT EST1				ALT EST2			
NLP	L_{CPA} m	RL dB re 1 µPa	Uncertainty dB re 1 µPa	NLP	L_{CPA} m	RL dB re 1 µPa	Uncertainty dB re 1 µPa
12	17375	123	20	12	17052	123	20
13	4727	132	18	13	4314	133	18
14	1073	143	15	14	2366	137	17
15	3156	135	17	15	3156	135	17
16	7128	129	20	16	7128	129	20
17	10058	127	20	17	10058	127	20
18	632	147	15	18	632	147	15

6.5.10.2 Impact of operation and maintenance

During pre-commissioning, underwater noise will be generated fromwater intake and dischange,in which pigging will also be used. Pipeline operation noise sources can be classified as either continuous or intermittent. During operation, noise will be generated by 1) gas-borne noise from pipeline and 2) maintenance work, such as the use ofvessels and helicopters. Based on data from similar reports, the noise impact from these actions will, however, be insignificant.

Summary of the significance of the impacts

The high levels of the underwater noise, which will exceed acoustic thresholds during pipeline construction, should be considered as a risk that marine organisms, especially mammals, fish and birds, will depart the marine protected areas.

The greatest risks are expected in the Pakri Natura 2000 and the Ingå Archipelago areas where Sound Pressure Levels will be highest during the construction phase (pipelaying and trenching). The noise impact during the operational phase is regarded as virtually insignificant.

In the Natura 2000 MPAs, marine mammals' acoustic thresholds should not be exceeded during pipeline construction. Marine mammals' acoustic thresholds for Behavior Disturbance Threshold, Temporary Threshold Shift, and Permanent Threshold Shift are as follows: BDT for Pinnipeds is not defined, for Catecean it is 145 dB re 1 µPa² s; TTS for pinnipeds is 171 dB re 1 µPa² s, for Catecean 164 dB re 1 µPa² s; PTS respectively 186 dB re 1 µPa² s and 198 dB re 1 µPa² s.

Table 6–14. Impact significance of the noise. C = construction phase, O = operating and maintenance.

	Impact significance	Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	**O** **No impact**	Low	Low	Moderate	High
	Moderate	High	High	Moderate	**C** **Low**	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.11 Vibrations

Vibrations caused by blasting were examined in the environmental impact assessment. Vibration levels were assessed in relation to distance from the vibration source based on available data and previous experience. The quantities of material removed through blasting were also examined in this context. Buildings located in the vicinity of the project area, as well as any disturbance experienced by people, were taken into account in the assessment.

There are several uncertainties relating to the assessment of vibration impacts. These include the geological characteristics affecting the propagation of vibrations, as well as the structural characteristics of the buildings possibly affected in the area. In addition, the level of vibration annoyance experienced and the occurrence of any damage are impacted by several different factors. The blasting surveys to be conducted at later stages of the project will enable surveys of vibration impacts through vibration measurements and impact calculations.

6.5.11.1 Impact of construction activities

During construction, vibrations from the environmental perspective are produced mainly by explosions carried out during blasting work in seabed intervention, and the blasting of the onshore natural gas pipeline corridor. Blasting may also be used in the clearance of underwater ordinance, such as mines.

According to preliminary estimates, there are a total of 52 peaks that will need to be removed along the entire pipeline route. On the Finnish side, the peaks will be removed using blasting (KP 0–26.9), and in offshore areas beyond KP 26.9 by dredging or ploughing. Off the Estonian coast, the intervention method employed will be dredging (KP 79.4–81.4) and, according to preliminary assessments, the volume of seabed to be excavated will total 39,000 m³. Final route optimization will involve the avoidance of bedrock. This means the amount of blasting required is likely to be below the preliminary estimates. In dredging, jetting or clay cutting will be used in excavation so that there will be no vibration impacts caused by blasting. Minor weakly detectable vibrations may occur in the close vicinity of the dredging site, but the vibrations will attenuate very rapidly in the marine area.

However, the thick limestone layer is a good medium for the transponding of vibrations during earthwork. In Estonia, in the ALT EST 2 alternative the pipeline transition from the offshore to the onshore section will be constructed using microtunneling, where a tunnel will be constructed underground (limestone) by installing concrete pipes to accommodate the gas pipeline inside. Microtunneling does not involve any blasting explosions. Instead, drilling is used as the bedrock intervention method. Excavators may also be used for launch shaft excavation. There may be minor weakly detectable vibrations in the close vicinity of the drilling and excavation site, but, unlike with blasting, these will not travel beyond the intervention site. In the ALT EST 2 alternative, the nearest residential properties are found around 2.4 km from the landfall site. No vibration impacts are estimated to occur on residential or recreational buildings, and therefore no adverse impacts on comfort are anticipated. For ALT EST 2, some meters of limestone will have to be opened – notwithstanding the use of a vibrating hammer, soil vibration will inevitably appear during the channel construction. In construction surveillance, the closeness of the Pakri wind farm will have to be considered. Although the generators are some hundreds of meters from the pipeline inrun point, the vertical position of the generators' pylons must not be affected.

The ALT EST 1 alternative will be implemented using the bottom pull method, where the trench will be excavated into the coastal cliff. The structures of the onshore natural gas pipeline for the ALT EST 1 alternative will also require excavation work. In onshore excavation, bedrock excavation will take place using a breaker and loosening. Excavation will be carried out using normal excavation equipment.

Excavation work relating to the ALT EST 1 landfall and onshore pipeline may result in vibration impacts in the environment. The vibration impact from excavation will be short-term in nature. Vibrations are usually detectable up to 500 m from the excavation site. The rate of vibration is also affected significantly by the structure of the bedrock and soil, their humidity, temperature and topography. On hard grounds (such as solid rock or glacial till), vibration attenuation is very rapid. Heavy construction machinery also generates ground vibrations, particularly if speed in pipe trenches exceeds 25 km/h.

The vibrations may damage structures and sensitive instruments, as well as cause annoyance in people and animals. Structural damage to buildings is not merely caused by the level of vibration. Instead, the structure's own weight, condition and other characteristics and loads affect a structure's vibration tolerance. Instruments sensitive to vibrations include computers, microscopes and measuring equipment, which may suffer from damage or breakage due to vibrations. In practice, the risk of structural or equipment damage resulting from excavation vibrations only occurs within 50–100 m measured directly from the excavation site. Human perception of vibrations is subjective. According to the United States Bureau of Mines (USBM), humans detect vibrations at peak particle velocities (PPV) of 2–10 mm/s, with PPVs exceeding 20 mm/s often causing annoyance.

In the ALT EST 1 alternative, the nearest residential building is located around 62 m from the pipeline to be constructed (Vanaranna). There are also a few other buildings within 100 m, and new residential buildings are being planned for the area. Excavation work may cause vibration impacts on all of these buildings, possibly resulting in temporary reductions in residential comfort.

6.5.11.2 Impact of operation and maintenance

No vibrations will arise from activities during pipeline operation.

Summary of the significance of impacts

In the ALT EST 2 alternative, the nearest residential properties are found around 2.4 km from the landfall site. No vibration impacts are estimated to occur on residential or recreational buildings, and therefore no adverse impacts on comfort are anticipated.

Excavation work relating to the ALT EST 1 landfall and onshore pipeline may result in vibration impacts in the local environment. The vibration impact from excavation will be short-term in nature. In the ALT EST 1 alternative, the nearest residential building is located around 62 m from the pipeline to be constructed (Vanaranna). Excavation work may cause vibration impacts possibly resulting in temporary reductions in residential comfort.

Table 6-15. Impact significance of vibration. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	**C Low**	**O No impact**	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.12 Air emissions

Dust generation caused by earthwork was estimated on the basis of excavation volumes based on preliminary design data. The estimate of air emissions from vessel traffic during construction was calculated based on the number and types of vessels involved in construction, as well as their use in construction. Emissions into the air were calculated on the basis of estimated vessel fuel consumption. The initial data for the vessels involved in construction in the Estonian survey area is shown in tables Table 6-16 and Table 6-17 below.

Table 6-16. Initial data for vessels involved in construction in the Gulf of Finland employed in emissions calculations.

	Useful power	Average distance	Period of operation, hours
Rock dumping vessels (Nordnes)	9 000 kW	40 km	890
Pipelaying vessel (Solitaire)	51 000 kW		490
Pipe transport vessels (3)	3 000 t	40 km	
Service vessel	2000 kW		490

Table 6-17. Initial data used in calculations.

Fuel consumption	190 g/kWh
Emission factors	
- Nitrogen oxides (NOx)	12 g/kWh
- particulate matter	1.35 g/kg of fuel
- carbon dioxide	3.2 t/t of fuel
Fuel sulfur content	0.1%

Amounts of emissions have been illustrated by comparing them with the total emission rates for the location municipality and emissions from the largest sources nearby.

Emissions into the air from vessels involved in offshore pipeline inspection and maintenance work were taken into account in the assessment of impacts arising during operation.

The uncertainties concerning vessel emissions relate to vessel traffic volumes and fuel consumption, which at this point are preliminary. Even taking into account the uncertainties, the air quality impacts of the project will be rather low.

6.5.12.1 Impact of construction activity

Air quality impacts during construction in the Gulf of Finland relate to exhaust gases from vessel traffic during pipelie transport, pipelaying and seabed intervention.

On the Estonian side, vessel emissions into the air will correspond to those in Finland, excluding emissions related to seabed intervention, which in Finland will take place closer to the mainland.

Vessel air emissions

Construction work will involve seabed intervention measures such as digging, dredging and blasting, rock dumping, munition clearance, pipe transport to pipelaying vessels, offshore pipelaying with associated support activities, and other activities involving vessels. Most of the air emissions generated by vessels will be caused by transport and vessel activity related to pipe transport, pipelaying and rock dumping. There will be one pipelaying vessel operating at sea during the pipelaying process. In addition to this, there will be three pipe transport vessels operating simultaneously – one unloading pipes onto the pipelaying vessel, one loading pipes from the onshore stockyard and one delivering pipes to the pipelaying vessel. Vessel air emissions relating to pipeline construction and installation will be generated over a period of two years, of which pipelaying will account for around two months. Emissions will be generated at sea, i.e. mainly in areas with no residences. The vessels will move forward as work progresses, so emissions sources will not be located in the same area during the entire construction phase. Consequently, the emissions will be dispersed over a large area.

Vessel traffic generates nitrogen oxide, sulfur dioxide, particulate and carbon dioxide emissions into the air. An estimate of the total emissions into the air from vessels involved in pipeline construction and laying is shown in the table below (Table 6-18) Around 59% of the total emission rate will be targeted at the exclusive economic zone of Finland, and 41% of that of Estonia. There is no significant difference between the alternatives. The impact of vessel traffic emissions on air quality is estimated to be low.

Table 6-18. Air emissions from vessels involved in offshore pipeline construction for the entire pipeline (tonnes total).

Nitrogen oxides	Sulfur dioxide	Inhaled particulate matter	Carbon dioxide
t	t	t	t
400	14	9	22 000

In 2012, annual emission rates from Baltic Sea shipping for nitrogen oxides totaled 370,000 tonnes, sulfur dioxide 84,000 tonnes, particulate matter 23,000 tonnes and carbon dioxide 19,000,000 tonnes (*Jalkanen 2013*). Emissions from vessel traffic involved in the construction of the Balticconnector project will be less than 1% of the current shipping emissions in the Baltic Sea area.

6.5.12.2 Impact of operation and maintenance

Air emissions at sea will be generated from pipeline inspections and maintenance.

Natural gas pipeline

No emissions into the air will be created in normal pipeline operation. Some blowdowns (releases of natural gas) will be carried out in conjunction with pipeline commissioning. These will result in minor methane (CH_4) emissions into the air since natural gas contains around 98% methane. Minor methane emissions will also take place in conjunction with pigging taking place during periodic pipeline inspections. Pipeline blowdowns will be required a few times a year. Natural gas transmitted in the transmission network is not odorized.

Inspections and maintenance of the offshore pipeline will be carried out from on board vessels throughout the operational life of the pipeline, i.e. 50 years. Emissions will be generated at sea and dispersed over an extensive area. The volume of vessel traffic involved in inspections and maintenance will be low. This means vessel air emissions and impacts on air quality will be low.

Summary of the significance of impacts

Guideline and limit values have been set for air quality, and limit values are in place for vessel sulfur dioxide emissions. The impacts will mainly be created further out at sea in areas where there are few people. Therefore the societal significance of the receptor is low. The receptor's susceptibility to change is low since a lot of shipping emissions already take place in the area. The sensitivity of the receptor has been assessed as low.

The impacts of the implementation alternatives on air quality during construction will last for two years, and focus on the vicinity of the vessels involved in construction, i.e. mainly on areas further out at sea where there are few people.

The impacts on air quality and climate during the operation of the natural gas pipeline will be low, with no clear difference seen between the alternatives.

Table 6-19. Impact significance on air. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	**C** **Low**	**O** **No impact**	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.13 Waste and waste handling

The impact assessment is based on project technical data, estimated waste types and an expert assessment conducted on the basis of these. Impacts during construction and operation were taken into consideration in the impact assessment. Uncertainty in the assessment is caused by the volumes of waste not being known at the project preliminary design stage.

6.5.13.1 Most common types of waste generated during the project

The waste generated from Balticconnector pipeline project can be classified into non-hazardous and hazardous waste.

Non-hazardous pipeline construction wastes include human waste, litter, pipe marking and spacers, waste from coating products, welding rods, timber skids, and rock.

All waste which contains (or at any time contained) oil, grease, solvents, or other petroleum products falls within the scope of the oil and hazardous substances control and disposal procedures. This material should be segregated for handling and disposal as hazardous wastes.

The most common types of waste generated during the Balticconnector project are shown in the table below.

Table 6-20. Most common types of waste generated during the Balticconnector project.

Classification	Physical form	Waste type
Non-hazardous	Solid wastes	Domestic/office waste
		Abrasive grit blast
		Metal cuttings
		Paper and cardboard
		Recyclable plastic
		Tires / rubbers
		Electrical cable waste
		Wood
	Liquid wastes	Oils - cooking oil
Hazardous	Solid wastes	Clinical waste
		Contaminated materials
		Oily rags
	Liquid wastes	Oils – lubricating oil/Oils – fuel
		Paints and coatings
		Solvents, degreasers and thinners
		Water - oily
		Water - hydrotest water
		Water - treatment chemicals

6.5.13.2 Impact of construction activity

All waste disposal will take place in compliance with applicable internationally recognized standards and methods and local legislation. Waste generated on board pipelaying vessels will be placed in tightly sealed containers. Such waste includes pipe milling and beveling waste, welding powder, pieces of heat-shrink sleeve, polyurethane filler and oils.

All (hazardous and non-hazardous) waste will be collected by a licensed contractor for disposal only at licensed and approved facilities. All everyday waste will be removed from the construction site on a daily basis unless otherwise approved or directed.

All drill cuttings and drilling mud from landfall approach methods (HDD or microtunneling) will be disposed of at approved locations. Disposal options may include spreading over the construction site in an approved upland location, or hauling to an approved licensed landfill or other site.

All rock and other natural debris will be removed from the construction site by the completion of clean-up. All litter and wastes from contractor yards, pipe stockpile sites, and staging areas, will be removed when the work is completed at each location.

It must be ensured that all hazardous and potentially hazardous materials are transported, stored and handled in accordance with all applicable legislation. Workers exposed to or required to handle dangerous materials must be trained appropriately and in accordance with the manufacturer's recommendations.

If toxic or hazardous waste materials or containers are encountered during construction, the work must stop immediately to prevent disturbing or further disturbing the waste material, and all relevant parties must be notified immediately. The work may not restart until clearance is granted.

There is no significant difference between the project alternatives as regards waste generation and handling during construction.

6.5.13.3 Impact of operation and maintenance

Small amounts of hazardous waste, such as lubricating oils, gas turbine cleaning fluids and glycol will be generated from natural gas pipeline inspection measures. The relevant regulations will be complied with in the handling of these. Inspection work during operation will also generate municipal waste at central control rooms. Waste generated during operation will be sorted by waste type.

There is no significant difference between the project alternatives as regards waste generation and handling during operation.

6.5.14 Impact on mineral resources

Under the Earth's Crust Act (*RT I 2004, 84, 572*), mineral resources are natural rock, sediment, liquid or gas, the deposit or part of which is included in the inventory in environmental register. The thickness of sand in the submarine coastal slope is unknown in the area of the landfall point in Kersalu. The geological and geotechnical data from the coastline to the 2.5 m isobath are inadequate. The sand resource in this zone may be of potential economic value, but due to environmental conditions its role may initially be passive.

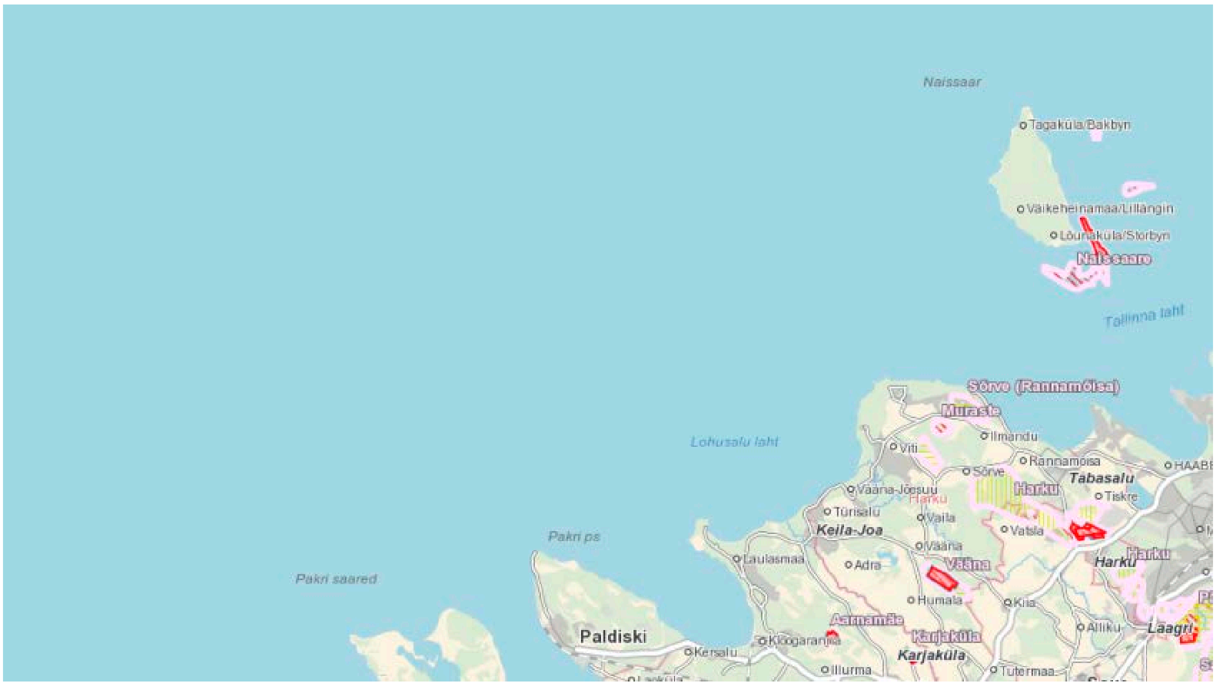


Figure 6-22. Extract from the mineral deposits map application of the Land Board *(Land Board 2014)*.

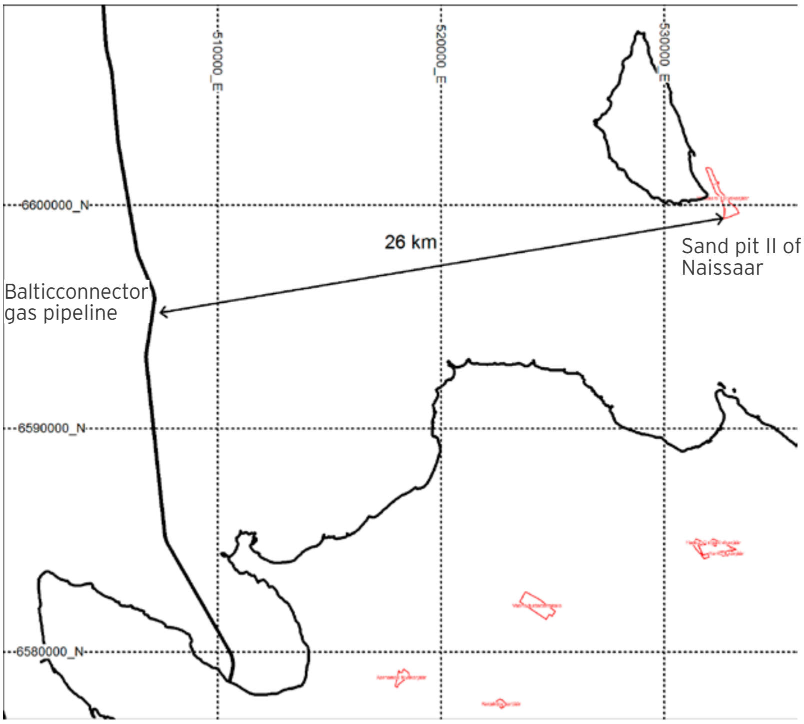


Figure 6-23. The closest marine extracting permit area to the gas pipeline route.

The closest marine extracting permit area "Sand pit II of Naissaar" is located 26 km east of the gas pipeline route (Figure 6-23).

6.5.14.1.1 Impact of construction activity

According to the Environmental Register (the mineral deposits and geology map application of the Land Board, see Figure 6-22 and Figure 6-23), no mineral deposits are located in the offshore part of the gas pipeline route. Seabed intervention, rock dumping, pipelaying and munitions clearance during natural gas pipeline construction could cause disturbance impacts on seabed extraction areas if these are located near the route. The impacts would be short-term and local. Seabed extraction activities are not, however, estimated to take place within such a distance of the pipeline where construction would result in impacts on extraction, and therefore the construction performed in the offshore part of the gas pipeline route has no impact on mineral resources.

6.5.14.1.2 Impact of operation and maintenance

Seabed extraction will not be possible along the natural gas pipeline route during pipeline operation. There is no current or planned seabed extraction activity in the vicinity of the natural gas pipeline.

The planned natural gas pipeline will restrict seabed extraction locally. The impacted area will be limited to the planned route, and not extend to other areas in the Gulf of Finland. Should seabed extraction be planned during the natural gas pipeline operation period near the route, the party responsible for the project must negotiate with the Project Developers of the Balticconnector project about the size of the protection zone required by the natural gas pipeline. Seabed excavation cannot take place within the protection zone. The protection zone is, however, narrow in relation to the size of seabed in the Gulf of Finland, so the impacts will not be significant. In addition, most of the natural gas pipeline route passes through sections that are too deep to be commercially viable for extraction using current technology. There is no significant difference between the project alternatives as regards seabed extraction because the alternative routings are located close to each other.

Summary of the significance of impacts

According to the Environmental Register (the mineral deposits map application of the Land Board), no mineral deposits are located in the offshore part of the gas pipeline route and therefore the construction, operation and maintenance performed in the offshore part of the gas pipeline route has no impact on mineral resources.

6.5.15 Impact on socio-economic environment

6.5.15.1 Impact on vessel traffic

The potential impact on vessel traffic may occur both in the construction and operation of the gas pipeline. The planned gas pipeline intersects with vessel traffic routes almost along the entire pipeline.

Impacts on vessel traffic will mainly depend on three variables: (1) traffic density in the relevant area; (2) the time during which traffic is disrupted and (3) complexity (possibility) of an alternative trajectory.

There is high traffic density in the Gulf of Finland – on average, 113 ships enter or exit the gulf per day (*HELCOM 2014*). The area with the most intense ship traffic is concentrated in the primary shipping lane of the gulf, where traffic entering and exiting the gulf is separated from each other (shipping lanes G and F in Figure 5–40 in section 5.1.15). In addition, several other areas of high traffic can be distinguished on the planned route. Finnish and Estonian traffic close to the coast are of a somewhat different nature. In the former, traffic is concentrated on official shipping lanes, in the latter, there are no official shipping lanes designated on the map, and traffic is more dispersed. In addition to larger ships equipped with AIS transponders, the coastal sea of Finland also has very heavy small boat traffic. Although the density of traffic of small boats is not as intense in the coastal sea of Estonia as it is in Finland, traffic is nonetheless considerable here also. This is shown, for example, by the fact that the Lohusalu harbor in the immediate area is visited by over 550 vessels per year.

6.5.15.1.1 Impact of construction activities

The primary impact on vessel traffic during the laying of the gas pipeline entails the establishment of an exclusion zone for traffic around the vessels involved in the work (installation of the pipeline, blasting, filling/leveling the seabedremoving mines), therefore other ships sailing in this area may be forced to change their usual and/or most optimal trajectory.

In the deeper parts of the Gulf of Finland, the pipeline will be laid on the seabed and is not covered. In the shallower parts of the sea and in landfall points, the pipe will be trenched and covered by a "rock mattress" if necessary to protect it from any damage that could be caused by the movement of ice, sediment transport or ship anchors. In Lahepere Bay, the pipeline is trenched in the seabed in a manner that the fill above the pipe would be at least 1m in section KP 79.4 – 80.9 km and 2.0 m in section KP 80.9 – 81.4 km. In the open sea where trenching is not carried out, the pipe laying vessel will be held in place by dynamic positioning. This means it is not necessary to anchor the vessel. The assumed rate of pipeline installation in the open sea is 4–5 nautical miles per 24-hour period. In the coastal sea where trenching and anchoring are necessary, the estimated duration of the work is approximately two years.

The pipeline will be assembled out of 12-m long pipes that will be transported to the pipelaying vessel using ships that can carry approximately 240 pipes. It is estimated that a total of 27 trips will be required throughout the construction of the pipeline.

A safety zone surrounding the pipe laying area must be coordinated with the relevant authorities (the Estonian Maritime Administration in Estonia) but that distance is presumably approximately 1.5 km from the pipe-laying vessel. This means that ships unrelated to the pipeline construction work must avoid an area of a 3 km diameter.

The impact in the open sea area of the route primarily depends on traffic density. To a certain extent, a more complex seabed topography (e.g. steep slopes) and intersection with existing pipelines will have an impact through slowing down the rate at which the pipeline can be laid. If the estimated pipelaying rate is 4–5 nautical miles per 24-hour period, it can be estimated that the impact on transport moving along the gulf in the different sections of ship traffic (see Figure 5–40 in section 5.1.15) will not exceed 48 hours. Taking into account the AIS statistics compiled by Ramboll (2013), the pipelaying rate and the safety zone of 1.5 km, it can be estimated that 4–20 ships will be forced to change trajectory in sections J, I, H and E and 65–70 ships will be forced to change trajectory in sections G and F due to pipeline installation work. As the section of the route located in the open part of the Gulf of Finland is navigable throughout, the construction of the pipeline will not cause any stoppages of vessel traffic there — ships will adjust their trajectories and make a detour away from the construction area. The incremental travel distance that ships are subjected to is at most 1–2 km, and the loss of time this causes is insignificant compared to other variables (weather, harbor operations).

There is a relatively high risk of marine accident in the Gulf of Finland. The most frequent cause of accidents is the human factor, e.g. of the ten marine accidents that occurred in the Baltic Sea in 2012 and resulted in pollution, in 8 cases a human was involved (*HELCOM 2014*). The most frequently occurring type of accident in the Gulf of Finland has been grounding (48%), followed by collision between ships (20%). Between 1997 and 2006, 42 collisions between ships occurred in the Gulf of Finland (*Kujala 2013*), representing an average frequency of four such incidents per year. Most of the known incidents of collision occurred under conditions of ice.

According to model simulations, the region with the highest risk of collision is the area between Tallinn-Helsinki, where passenger vessel traffic between the cities meets the east-to-west traffic route of cargo vessels and tankers (*Kujala 2013*). According to AIS data, 2,122 ships sailed in the north–south direction in the region in July 2006 and 2,303 ships sailed in the east-west direction. Using this month-long timeseries of ship trajectories Kujala et al. (2013) have estimated by modeling that a collision between ships may occur in the area on average every 11 years. The paper also mentions that collision risk in that region is higher due to the operation of high-speed craft.

It can be expected that the east-west traffic in the area of the gas pipeline route is of a somewhat higher density compared to the Tallinn-Helsinki area (*HELCOM 2014*). However, the pipelaying vessel will move at a very slow speed (average speed of 300–400 m/h). Hence, unlike the Tallinn-Helsinki area, in this case there is no risk arising from ships sailing across the gulf. Additional traffic volume to some extent will result from the ships carrying the pipes, but it is of a marginal nature considering the overall traffic volume in the Gulf of Finland. Thus, compared to the area between Tallinn and Helsinki, the risk of collision arising from the construction of the gas pipeline is significantly lower.

Large ships sailing on the open sea have very long inertia and must change course early. Therefore, it is necessary for the ships to be informed early by using various notification resources (VTS, GOFREP). The official shipping lane located in the middle of the gulf (Figure 5–40 in section 5.1.15 sections G and F), the separation zone is sufficiently wide so as to prevent entering the zone of oncoming traffic. Although in Estonian waters there are no shipping lanes (according to the definition of the Maritime Safety Act Section 2 (10[1]) designated on the map intersecting with Balticconnector, the so-called right-hand rule of traffic in the waterways has been established over time. For instance, section I of the shipping lane (Figure 5–40 in section 5.1.15), starting from between Suurupi and Naissaar (where a official shipping lane with a separation zone exists), traffic heading west (northern) and heading east (southern) is clearly separated also at the point of intersection with the planned gas pipeline route. It is important for ships not to be directed to an area where traffic predominantly has an opposite course. In this respect, the pipeline layer must work together with the relevant authorities ensure the re-routing of ships is as safe as possible.

The entire Estonian coastal sea area within the route of the planned gas pipeline (except short sections by the alternative landfall points) is in excess of 20 m deep and navigable. In both alternative landfall points on the Estonian side, the coastal sea has a steep slope, i.e. the sea gets deep quickly. In both alternative locations of the route, 10 m isobath is approximately half a nautical mile away from the coastal line and the 5 m isobath is a few hundred metres away. Due to this and based on an estimated 1.5 km exclusion zone, small vessels will already be able to cross the pipeline route from the coast side when 2 km of gas pipeline have been laid from the coastline. Thus, the impact on small local vessel traffic near the coast is of a short-term nature.

The impact on vessels sailing along the Estonian coast is also of a short-term nature and moderate. According to the location of the pipelaying vessel, trajectories will be adjusted and the pipeline will be passed from the north or the south. Although impact on vessel traffic in the Estonian coastal sea is short-term and moderate in the case of both alternatives, it must be noted that when comparing the alternatives, the duration of impact is probably slightly longer in the first alternative (landfall point in Kersalu). This difference is mostly marginal, however.

Additional vessel traffic above the pipeline route will, to a certain extent, also result from subsequent use of the gas pipeline. Trips for maintenance and survey work are mostly seldom and of short duration, and will not significantly impact traffic in the Gulf of Finland.

It can be concluded that the construction of Balticconnector pipeline will have a short-term impact on the vessel traffic in the Estonian coastal sea and the open part of the Gulf of Finland. As the sea area bordering the route is naturally navigable throughout (except for a coastal zone of approximately 0.5 nautical miles), pipeline construction will not cause stoppages in vessel traffic – ships will adjust their trajectories and make detours around the construction area. Related loss of time is insignificant compared to other variables (weather, harbor operations). Construction of the gas pipeline will not significantly increase the risk of shipping accidents in the Gulf of Finland. Both of the alternative landfall points on the Estonian side are acceptable from the standpoint of impact on vessel traffic and do not substantially differ from each other. The pipeline layer must work together with the relevant authorities ensure the re-routing of ships is as safe as possible.

When the schedule of work has been determined, the Project Developers should communicate it to the institutions that are potentially interested, such as Paldiski Northern Port, Paldiski South Harbour, Lohusalu Marina, Estonian Yachting Union and others.

6.5.15.1.2 Impact of operation and maintenance

Regular inspections and maintenance inside and outside the pipeline will take place during pipeline operation. Activities relating to pipeline maintenance will create some vessel traffic along the pipeline route. The vessels may cause temporary disturbance to other vessel traffic during maintenance work. The measures will, however, last for a very short period, take place seldom and only take place in a small area at a time, whereby the impacts on other vessel traffic are estimated to be low. During the operation of the natural gas pipeline, the pipeline route may restrict the availability of anchoring sites and pose risks in the form of gas leaks or vessel grounding.

Summary of the significance of impacts

It can be concluded that the construction of Balticconnector pipeline will have a short-term minimal negative impact on the vessel traffic in the Estonian coastal sea and the open part of the Gulf of Finland. As the sea area bordering the route is naturally navigable throughout (except for a coastal zone of approximately 0.5 nautical miles), pipeline construction will not cause stoppages in ship traffic – ships will adjust their trajectories and make detours around the construction area. Related loss of time is insignificant compared to other variables (weather, harbor operations). Construction of the gas pipeline will not significantly increase the risk of shipping accidents in the Gulf of Finland.

6.5.15.2 Impact on fishing

Adverse effects on fishing in the offshore areas of the Gulf of Finland will mainly be caused by the prevention of trawling in the project area during construction. Fishing vessels operating in the area will be disturbed by increased vessel traffic, seabed intervention work, pipelaying as well as pipeline protection measures. For example, a great deal of seabed intervention work will be carried out in trawling areas, and this is likely to result in restrictions to access by other vessels in the area during the work. In addition, measures such as blasting may deter fish from their typical distribution areas, making it more difficult to locate them.

All of the above-mentioned impacts during construction will be temporary and of short-term local duration. The significance of the adverse impacts on trawling will also largely depend on the timing of the work. The adverse impact on fishing during construction is estimated to be low or moderate depending on the timing of the work.

The gas pipeline will be located in an area where trawling is carried out. Trawling in the area is mainly mid-water and surface trawling. According to studies conducted (*Ramboll 2013a, Ramboll 2013b and Ramboll 2013 c*), the share of bottom-trawling is very small on the Finnish as well as on the Estonian side and does not even take place every year. It is, however, possible that bottom-trawling will become more common in the area in the coming decades. The Balticconnector gas pipeline will be covered in the trawling areas so as to ensure it will not disturb trawling. The reconciliation of offshore gas pipelines and fishing has been studied extensively regarding the North Sea, and guidelines are available for design (*DNV 2010*).

Once covered, the gas pipeline will not cause an adverse impact on offshore fishing. The impact is estimated to be insignificant (no impact) or very low.

Project activities and their potential impact on fishing to be assessed in Lahepere Bay are as follows:

Construction – restricted zones due to blasting and other construction work may obstruct fishing boats and vessels, and it may therefore not be possible to follow regular fishing routes. Construction work will also have a negative impact on the fish fauna in the area, and this may affect fishing.

Operation – vessel traffic in the area associated with operating the pipeline, which obstructs the regular movement of fishing boats and vessels as well as following usual fishing routes.

Coastal fishermen in the project area mostly fish Baltic herring, flatfish, perch and round goby, the first three of which are commercially important species. The most common instruments used are gillnets and fyke nets; longlines and side fyke nets are far less common. The main fish species for fishing vessels in the project area are sprat, smelt and Baltic herring. Most of the fish are caught using a pelagic trawl with trawl boards. Bottom trawl was not used in 2011 and 2013 in the project area; it was used to a very small extent in 2012. The amount of fish caught in the study area based on fishing permits issued to fishermen and fishing vessels has decreased by approximately 50% in recent years (*Ramboll 2013c*).

There are around 112 fishermen or entrepreneurs issued with a fishing permit from 2011 to 2013, as well as 21 companies or cooperatives issued with a fishing vessel permit in the project area (*Ramboll 2013*).

6.5.15.2.1 Impact of construction activity

Commercially important species in the project area from the perspective of fishing are sprat, Baltic herring, flatfish, perch and smelt. A decrease in these populations would harm the fishing sector in the area. The impact of construction work on fish fauna is described in section 6.5.5.

6.5.15.2.1.1 Movement restrictions during construction of the pipeline

During construction (pre-lay and post-lay seabed intervention work, pipeline laying) there will be safety zones in the area for all vessels not involved in pipeline construction work, including fishing vessels and boats, in order to avoid collisions and disturbances (*Ramboll 2014a*). This means that fishermen cannot trawl or use passive fishing methods in a max. of 1,500 m radius from the pipeline. According to plans, the pipeline will be laid at a rate of 4–5 km per day (*Ramboll 2014a*). The duration of the construction is estimated to be two years, but restrictions occur in certain short phases of the construction. This will probably have the largest impact on trawling vessels because they have to change their usual trawling routes. Changing the location of stationary instruments is easier. On a local level the negative impact of construction work on fishing is moderate and reversible, depending directly on the duration of the safety zones in place.

Vessel traffic in Lahepere Bay before initiating the construction of the pipeline is very limited – up to ten ships per year (*Ramboll 2013*). Outside the bay towards the open sea, vessel traffic can be up to 300 ships per year depending on location (*Ramboll 2013*). Therefore, the additional vessels will mostly change the situation for fishermen working in areas with infrequent traffic (Lahepere Bay) who did not have to earlier consider higher traffic volume earlier. The safety zone around the pipeline is estimated to be 1,500 m, which will also affect usual trawling routes. The impact of construction vessel movement and the establishment of a temporary safety zone on fishing is estimated to be moderate and reversible.

6.5.15.2.1.2 Impact on fish fauna

Balticconnector pipeline construction work will have a negative impact on regional fish fauna, which will in turn affect fishing. The effect of Balticconnector pipeline construction on fish fauna is described in detail in section 6.5.5. It can be assumed that during construction work there will be fewer fish in the area and this will have a negative impact on fishing.

However, this impact is reversible, and most fish will probably return to the area once the work has been completed (*Nord Stream Espoo Report: Key Issue Paper. Fish and Fishery. February 2009*). Therefore, the impact on fishing deriving from fish fauna during the construction period is assessed as moderate and reversible. The original natural conditions regarding fish fauna will presumably be restored once the project activities have been completed.

6.5.15.2.2 Impact of operation and maintenance

During operation, fishing activities can be indirectly impacted by the existence of the pipeline on the seabed as well as vessel traffic due to maintenance and repair, since usual ship traffic in the area is very limited.

6.5.15.2.2.1 Existence of the pipeline on the seabed

No additional permanent fishing restrictions will be applied during the operational phase (*Ramboll 2014a*). In order to protect the pipeline from anchors and fishing instruments, the pipeline will be laid in a trench and covered with rocks (*Ramboll 2014a*). The pipeline will be protected in the following kilometer posts in Estonian waters: 6270 and 7679.4 kms (*Ramboll 2014a*). These locations have been chosen based e.g. on locations where the contact between human activity (including trawling) and the pipeline is most likely. Therefore, it is assumed that the pipeline will not have a direct impact on fishing activities.

Chapter 6.5.1 describes the potential impact of the existence of the pipeline on the seabed, and states that the number of fish (including juvenile fish) near the pipeline may increase because of the creation of an artificial habitat with additional hiding places and various food sources. For example, the amount of fish near wind farms has increased because turbine foundations form so-called "artificial reefs" (*Wilhelmsson 2006, Reumens 2013 and Bergström 2013*. Such habitats are known to be favorable for cod, perch and sculpin (*Bergström 2013)*. This, in turn, can cause more intensive fishing near the pipeline. It can have a negative impact on the populations of commercially important species at a local level, but there is no impact on a greater scale because the amount of fishing in Lahepere Bay is not very high.

It can therefore be concluded that the existence of the pipeline on the seabed will not have any impact on fishing.

6.5.15.2.2.2 Vessel traffic due to operation work

Fishing can be disturbed by vessel traffic in the area due to pipeline operation and maintenance. Maintenance will take place irregularly and as needed. It can therefore be concluded that vessel traffic due to pipeline operation and maintenance will not have any impact on fishing.

Summary of the significance of impacts

It can be assumed that during construction work there will be fewer fish in the area and this will have a negative impact on fishing. However, this impact is reversible, and most fish will probably return to the area once the work has been completed. Therefore, the impact on fishing deriving from fish fauna during the construction period is regarded as moderate and reversible. The original natural conditions regarding fish fauna will presumably be restored once the project activities have been completed.

The existence of the pipeline on the seabed can have a negative impact on the populations of commercially important species at the local level, but there is no impact on a greater scale because the amount of fishing in Lahepere Bay is not very high.

Table 6-21. Impact significance on fishing. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	**O No impact**	Low	Low	Moderate	High
	Moderate	High	High	**C Moderate**	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.5.15.3 Impact on underwater monuments of cultural heritage

Some of the pre-lay preparation work will involve excavating peaks on the seabed along the pipeline route to reduce or eliminate the free spanning pipeline. Excavation can be performed either by dredging or blasting, depending on the soil conditions and the environment. Excavation activity may cause shockwave and sediment spreading. The natural gas pipeline laid on the seabed may cause impacts on the underwater cultural heritage either due directly to construction or due to changes in water flows resulting from construction. Blasting may also cause mechanical damage to items.

There are a number of shipwrecks in the Gulf of Finland. The shipwrecks near the pipeline route are shown in Figure 6-24.

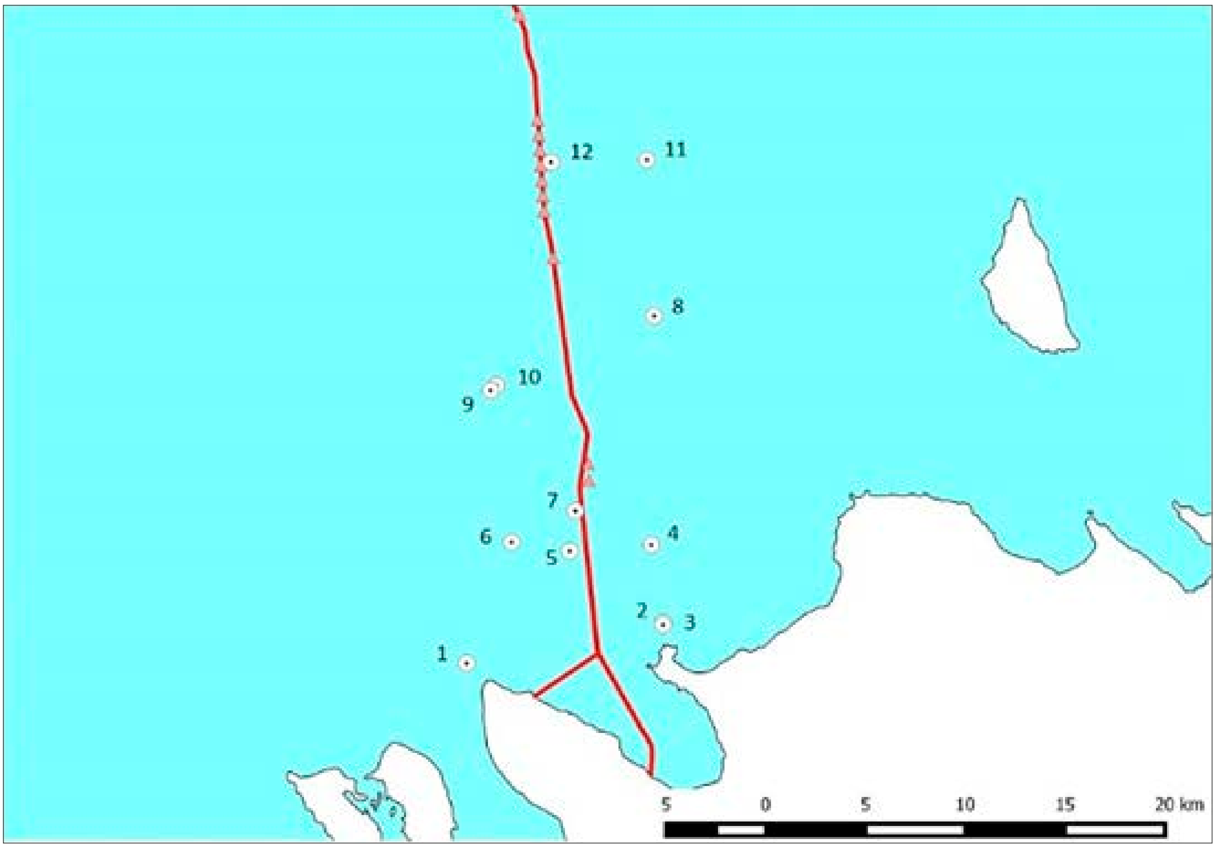


Figure 6-24. Shipwrecks near the pipeline route on the Estonian coast of the Gulf of Finland are indicated by dots. Excavation points along the pipeline route are indicated by triangles.

According to the the side scan sonar surveys performed by MMT in 2006 and 2014, there are 11 previously known wrecks and one possible wreck, which is not confirmed within a distance of 3 nautical miles of the pipeline (*SubZone 2015*). One possible wreck is marked on sea chart F20 (No 12 on Figure 6–24), but not confirmed. There are no wrecks found on the pipeline route itself. Shipwrecks are presented in section 5.1.17, Table 5–18 and Figure 5–42, also Figure 6–24.

The Estonian National Heritage Board requires a minimum two cable lengths (370.4 meters) on both sides of the pipeline to be surveyed forming a corridor of 0.4 nautical miles (740.8 meter) wide. The side scan sonar surveys performed by MMT in 2006 and 2014 do not cover this requirement in any part of the pipeline (*SubZone 2015*). It is suggested a new side scan sonar survey be performed covering a corridor of four cable lengths (740-meters) to supplement MMT's survey(*SubZone 2015*).

According to the Estonian National Heritage Board's instruction, precision inventories of the wreckage areas of Zeleznodoroznik and Nimetu –178 are to be made to determine whether the wrecks' debris area extends to the pipeline impact area (*SubZone 2015*). These wrecks are suggested to be documented by video filming with ROV/divers and the surrounding area by side scan sonar. Possible wreck F–20 is suggested to be checked by side scan sonar to see whether it exists (*SubZone 2015*). If there is a wreck in the given position, it will be in the direct impact area of the pipeline and will be documented by video filming with ROV/divers. It is suggested that all anomalies detected in the four cable length corridor that could refer to objects with historical or cultural value are e documented by video filming with ROV/divers and further studied according to the Estonian National Heritage Board's instructions.

6.5.15.3.1 Impact of operation and maintenance

The offshore sections of the natural gas pipeline will not cause any impacts on the cultural environment during operation.

6.5.15.4 Impact on monitoring stations

Chapter 5.2.10 presents an overview of monitoring stations and areas at Pakri Peninsula, Lahepere Bay and the open part of the Gulf of Finland within the Estonian exclusive economic zone, which are the closest stations to the gas pipeline. None of the monitoring stations and areas are directly on the route of the pipeline, and during pipeline construction and operation there will be no movement directly in monitoring areas or near them. The gas pipeline will be constructed within a specified corridor at sea as well as on land.

6.5.15.4.1 Impact of construction activity

The closest monitoring station to the gas pipeline is the monitoring station pe in the western part of the Gulf of Finland, which is located in Lahepere Bay and about 300 m to the southwest of ALT EST 1 gas pipeline route toward Leetse saunakivi on the western coast of Pakri Peninsula in Lahepere Bay. In this section, the gas pipeline will be laid directly on the seabed at a depth of 20 m from a ship and covered with rock for protection.

The closest monitoring area to the gas pipeline is coastal monitoring Kersalu profile no. 4, which is located on the western coast of Lahepere Bay and 100 m north-west of the landfall of ALT EST 1. Construction work carried out in the vicinity of these closest monitoring locations does not obstruct monitoring at the same time.

There will be no impact on monitoring stations and areas during the construction of the gas pipeline.

6.5.15.4.2 Impact of operation and maintenance

There will be no impact on monitoring stations and areas during the operation of the gas pipeline.

6.6 Onshore natural gas pipeline

6.6.1 Impact on soil

6.6.1.1 Impact of construction activities

The impact of construction activities on the soil largely depends on the tunneling method and choice of landfall site for the route.

In the Kersalu landfall location (ALT EST 1)**,** where the plan is to build it in a trench, the impact on the soil in the land section of the affected area will be significant, since a limestone deposit (hard crag rock) up to 8 m thick has to be penetrated. Although the boundary of the Pakri Landscape Reserve Area runs some hundred meters to the north of the landfall location, within the Pakri Special Protection Area, it is effectively still the same partly buried klint scarp, the Ordovician scarp. It should be considered whether it would be technically possible to also use the option of an environmentally safer closed construction method in the Kersalu landfall area to preserve the appearance of the landscape of the klint scarp. Any damage to the soil due to construction activity along the segment of the route approximately 1.3 km long, comparable in terms of its scope and impact to those of the construction of a regular sewer, will not be significant and will be within acceptable limits.

In the Pakrineeme landfall point (ALT EST 2), which is within the Pakri Landscape Reserve Area, the plan is to use the microtunnel option to build the landfall. This will cause minimum damage to the main feature in the Pakri Landscape Reserve Area, the one potentially most affected by construction activity: the Cambrian / Ordovician scarp of the Baltic Klint.

Since there are no deposits in any of the areas to be affected on land (*Suuroja 2010*), there can be no discussion of the impact of construction activity on them.

6.6.1.2 Impact of operation and maintenance

The impact of the operation and maintenance of the route is also small on the soil along the route running on a base of strong crag rock in the affected area with a mostly thin top soil.

Summary of the significance of impacts

In the Kersalu landfall point (ALT EST 1), where the plan is to construct landfall in a trench, the impact on the soil in the land section of the affected area will be negatively high. The closed construction method (as planned in Pakrineeme ALT EST 2) will cause minimum damage to the main feature in the planned new area of the Pakri Landscape Reserve Area, the Cambrian / Ordovician scarp of the Baltic Klint.

Table 6-22. Impact significance on soil.

Impact significance		Magnitude of change								
		Very high	High	Moderate	Low	No change	Low	Moderate	High	Very high
Sensitivity of receptor	Low	High	Moderate	Low	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	Moderate	ALT EST 2 Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	ALT EST 1 High	High	No impact	High	High	Very high	Very high

6.6.2 Impact on surface- and groundwater

6.6.2.1 Impact of construction activity

The mouths of the streams lie within 3 km and 9 km to the northeast of the ALT EST 1 and ALT EST 2 landfall points of the gas pipeline respectively. The nearest, Kersalu Waterfall, lies 0.5 km to the northwest of the ALT EST 1. There will be no impacts on the streams from the construction of the gas pipeline. The southern branch trench of Kersalu Waterfall crosses the proposed gas pipeline approximately 40 m to the northwest of Tallinn National road 8. The gas pipeline will not prevent the current drainage of drained water, and there is little impact. All in all, the impact of the proposed activity on surface water will be limited during construction.

The impact of construction on the surface water and groundwater in the land section of the area under consideration will depend largely on the location of the landfall of the route (either Kersalu or Pakrineeme) and on the engineering solutions utilized in the construction of the route. Mostly, the areas of the available route options are unprotected areas (subject to a high pollution hazard), that is, they include areas where groundwater is unprotected from both organic and mineral pollutants. These include alvars with thin (< 1 m) top soil, and also areas of shingle / gravel drift lines with a top soil of over 2 m (*Suuroja 2010*). Areas subject to a high pollution hazard are the most extensive within both the Paldiski area and the route areas on Pakri Peninsula. Poorly protected areas (subject to pollution hazard) include a small patch of swamp in the east of Pakri Peninsula, along the Kersalu segment of the route. Nonetheless, the environmental impact of construction activity in either route option may be estimated to be small, due to favorable hydrogeological conditions: the entire route area, largely extending across hard crag rock (crush resistance 100 – 150 MPa), as well as large part of the landfall section are above the water table, and are protected by an effective Ordovician aquifer from underneath.

Dewatering from the pipeline trench may generate depression of underground water (groundwater) in the adjacent area. It is estimated that in the case of overmoist soils (peat or limestone layers), the drying-up zone can extend to 20 m from the trench. In both alternatives, i.e. ALT EST 1 and ALT EST 2, there are no groundwater wells in the vicinity of the pipeline trench which would be affected by possible depression during pipeline construction.

In the case of the ALTEST1 alternative, the closest bored well (see Figure 5-48) is at a distance of some 25 m from the gas pipeline. The water table measured January 1, 1978 appeared to be 1.9 meter below ground level. The well was not found during site visit February 20, 2015. It is likely that during a dry period, the groundwater level will remain below the level of the bottom of the pipeline trench. In exceptional cases, i.e. if the pipe trench is excavated into wet soil (1-m thick clay-sand moraine on a limestone layer), then the depression of the ground-water table would be evident up to 10 m on either side of the pipeline. Excavating a trench will have no impact on the groundwater to the well referred to. In the case of the ALTEST 2 alternative, there are no bored wells within a distance of 100 m of the gas pipeline trench.

6.6.2.2 Impact of operation and maintenance

During the operational phase there will be no impact on ditches nor streams.

The impact of the operation and maintenance on the surface water and groundwater in the land section of the affected area is also to an extent dependent on the geological structure of the landfall area. In the case of the Pakrineeme landfall point, the adverse impact will be greater, since the route passes through a thicker rock complex (approximately 23 m at Pakrineeme and approximately 10 m at Kersalu). Although the landfall areas are mostly very poorly protected areas (*Suuroja 2010*), given that these are also areas of drain surface water and groundwater, being protected from underneath by the Ordovician aquifer, the potential impact of operation and maintenance on the surface water and groundwater may be estimated to be small.

Summary of the significance of impacts

The main impacts on surface and groundwater are related to construction activities. The impact accrues due to water level depression on the pipeline route. The impact is local, negative-low and recoverable after the construction period. There will be no impact during operation.

Table 6–23. Impact significance on surface and groundwater. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	**C** **Low**	**O** **No impact**	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.6.3 Impact on air quality

6.6.3.1.1 Impact of construction activities

Earthworks

The impacts on ambient air quality are related to the use of heavy machinery for trench or microtunneling and the laying of the gas pipeline. The impact generated by earthwork – dust emission, especially during drought, and the release of diesel engine exhaust gases can be differentiated. Earthwork will generally be carried out in the daytime, whereby any impacts from construction will be limited to daytime hours between approximately 7:00 and 22:00. The duration of earthworks will be less than a year.

It is estimated that at least three machines (bulldozer, rock-hammer, pipe-hanger) with a 110 kW diesel engine will be engaged during the working day. The engine exhaust emissions consist of carbon monoxide, nitrogen oxides, non-methane hydrocarbons and very fine particulates. According to the data in the Regulation of the Ministry of Environment No. 122 on September 22, 2004, Annex 3, the instant emission of the aforementioned pollutants during a maximum load of three engines can reach 600 mg/sec. At worst, this load can generate dispersion (fumigating plume of nitrogen oxides, which is a pollutant affecting both human health and nature, > 100 micrograms/m³ at distance of 100 m from the worksite.

Thus, in the case of ALT EST 1, pollutants from diesel-operatingmachinery will add to the adverse impact on ambient air quality from local traffic near the pipeline corridor. The plants on the pipeline corridor should be considered as the recipients of this local, temporary and moderate adverse impact.

In the case of ALT EST2, the adverse impact is expected to be smaller since the pollutants will undergo rapid mixing in a higher and open alvar type landscape.

The volume of excavation that will take place in the worksite and onshore pipeline sections from the pipeline landfall to the compressor station will total around 1,300 m³ for the ALT EST 1 alternativeand around 2,000 m³ for the ALT EST 2 alternative. Dust generation related to earthworks is estimated to be restricted to the immediate vicinity of the worksite.

There are significant differences between the ALT EST 1 and ALT EST 2 landfall alternatives as regards dust generation. While the ALT EST 1 will be constructed using digging and excavation through a limestone cliff, ALT EST 2 will be constructed using drilling through limestone, resulting is a lot less dust generation than ALT EST 1.

6.6.3.1.2 Impact of operation and maintenance

Natural gas pipeline

No emissions into the air will be generated in normal pipeline operation. Some blowdowns (releases of natural gas) will be carried out in conjunction with pipeline commissioning. These will result in minor methane (CH_4) emissions into the air since natural gas contains around 98% methane. Minor methane emissions will also take place in conjunction with pigging taking place during periodic pipeline inspections. Pipeline blowdowns will be required a few times a year. The amount will be very small. Methane is a significant greenhouse gas alongside carbon dioxide. The global warming potential of methane is 25 times greater than that of carbon dioxide. Natural gas transmitted in the transmission network is not odorized.

Summary of the significance of impacts

Emissions from and impacts on air quality and climate during construction of landfalls ALT EST 1 and ALT EST 2 will be quite low and do not significantly differ from each other. The impacts of the alternatives on air quality during construction will last for less than two years, and be concentrated in the vicinity of the vessels involved in construction, i.e. mainly in areas further out at sea where there are few people.

The impacts on air quality and climate during the operation of the natural gas pipeline will be low, with no major difference seen between the alternatives.

Table 6-24. Impact significance on on air quality. C = construction phase, O = operating and maintenance, L = Lahepere bay, OS = open sea.

Impact significance		Magnitude of change								
		Very high	High	Moderate	Low	No change	Low	Moderate	High	Very high
Sensitivity of receptor	Low	High	Moderate	Low	C Low	O No impact	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	Highe	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.6.4 Noise

Onshore noise

This chapter includes noise from onshore activities and costal zone offshore activities. Onshore environmental noise arising from natural gas pipeline construction and normal operation was assessed on the basis of noise modeling for the ALT EST 1 and ALT EST 2 alternatives and the corresponding landfalls. Assessment does not cover the construction and operation of the compressor station.

Above-water activities near the coasts during pipelaying as well as onshore activities during construction were modeled using the same static noise propagation calculation by utilizing the calculation of noise exposure level L_{AE} for sound source emissions. As continuous progress will be made in the activities, it is possible to determine the equivalent sound level L_{Aeq} situation within one daytime period. In this it is assumed that construction can take place in the daytime between 7:00 and 22:00 and that progress will be made within one day by the pipelaying vessel near the coast.

The noise impact examination area extends in Paldiski on the pipeline route from the sea and the compressor station approximately 1 km from the noise source up to the 45 dB(A) propagation plot. Noise propagation over the terrain was illustrated using computer software on noise dispersion where sound waves from sound sources are calculated onto a digital 3D map as sound pressure at the immission (reception) point. The software used was CadnaA v.4.4 (Datakustik GmbH) with the Nordic noise modeling method (*Kragh 1986*). The model takes into consideration the geometric attenuation of noise, topography, buildings and other reflective surfaces as well as absorption constants for the ground and atmosphere. Noise sources can be determined as point, line or surface sources.

The noise map produced provides average noise sound level plots with initial parameters selected at 5 dB intervals. The Nordic Prediction Method was employed in the noise propagation calculations. The impact of forest and softer soil was taken into consideration by using restricted ground absorption areas. Hard ground is generally determined for industrial facilities, water and road surfaces. Noise propagation is typically calculated conservatively in the model, with environmental conditions points set as favorable for noise dispersion (slight tailwind from noise source to each calculation point).

Both estimated as well as the measured values for corresponding components (including rock drilling and blasting, pipelaying vessel, compressor station noise sources and general construction period noise) were utilized in the initial sound power level values (total sound power level L_W and frequency spectrum by octave band) for the noise calculations. The determinations of building sound source sound power levels included interior-to-exterior noise in a manner whereby wall materials were assumed to have the rate of airborne sound insulation of an industrial building typical for the material's properties.

As a general rule, surface sound sources were used to, for example, cover an entire building's wall surface area and area sources for an entire set of buildings. Some compressor station functions were also modeled as individual point or surface sources of sound. The sound source descriptions are, however, only preliminary at this stage, and they cannot be determined specifically due to the general nature of the preliminary design process.

The further away the noise source is, the more significant the impacts of annual weather variation and wind direction in particular will be on the actual sound level of an area. Therefore the uncertainty of the calculations increases the further an area is from the sound sources. In addition, the uncertainty of the assessment is affected by the assessments of noise emission levels and the locations of noise emission sources. Typically the uncertainty involved in the calculation part only is around ± 3 dB to a distance of 1 km. The total uncertainty here was estimated as slightly higher (+2 –5 dB), with the project modeled as in compliance with the presumed maximum and noise-generating activities taking place throughout the period of operation at 100% capacity. The results of the noise modeling were applied to the assessment of impacts in the offshore areas of the Gulf of Finland.

6.6.4.1.1 Impact of construction activity

Paldiski

On the Pakri Peninsula, construction will mainly take place on-shore, with small amounts of soil excavation taking place. According to the noise modeling carried out for above-water and onshore construction for pipelaying for the Pakri Peninsula routing alternatives ALT EST 1 and ALT EST 2, in land areas where the construction of the onshore pipeline section will take place without major excavation work, the daytime 45 dB(A) noise zone may extend to a radius of around 200 m during the busiest construction period.

According to the preliminary plan, in the ALT EST 1 pipeline routing alternative there will be three different residence sites within the 50 dB(A) noise zone (industrial noise guideline value for daytime, residential areas, category II).

For the ALT EST 2 project alternative, possible noise impacts from landfall construction in front of the steep cliff at the landfall site were also taken into consideration in addition to the pipelaying vessel in the noise predictions for the construction period. According to the preliminary plan, there will be no sites within the 50 dB(A) noise zone (industrial noise guideline value for daytime, residential areas, category II) during the construction of the pipeline.

ALT EST 1 routing alternative

Above-water noise propagation for pipelaying in the ALT EST 1 alternative is shown in the noise map below (Figure 6–25).

According to the modeling, the 45 dB(A) noise zone may extend to around 500 m from the planned pipelaying vessel route on both sides of the vessel. In this routing alternative there are no holiday residences within the 45 dB(A) zone before the point where the route alternatives merge with each other. At the merging point the average sound level for a day may exceed the 45 dB(A) daily guideline value. All in all the noise impacts will, however, be short-term.

At sections passing the nearest nature conservation areas the noise level may, according to the modeling, be around 45–50 dB(A), which is slightly above the daily guideline value of 45 dB(A) set for nature conservation areas. The 45–50 dB(A) zone will pass through a Natura 2000 site (established to protect birds). The noise load will, however, be temporary and only last for few days in the calculation area.

ALT EST 2 routing alternative

Above-water noise propagation for pipelaying in the ALT EST 2 alternative is shown in the noise map below (Figure 6–26).

According to the modeling, the 45 dB(A) noise zone may extend to around 500 m from the planned pipelaying vessel route on both sides of the vessel. At the merging point of the routes the average sound level for a day may exceed the 45 dB(A) daily guideline value. All in all the noise impacts will, however, be short-term.

6.6.4.1.2 Impact of operation and maintenance

Noise impacts during operation will be low and very local. Local residents will always be notified in advance about the dates and times of pipeline blowdowns.

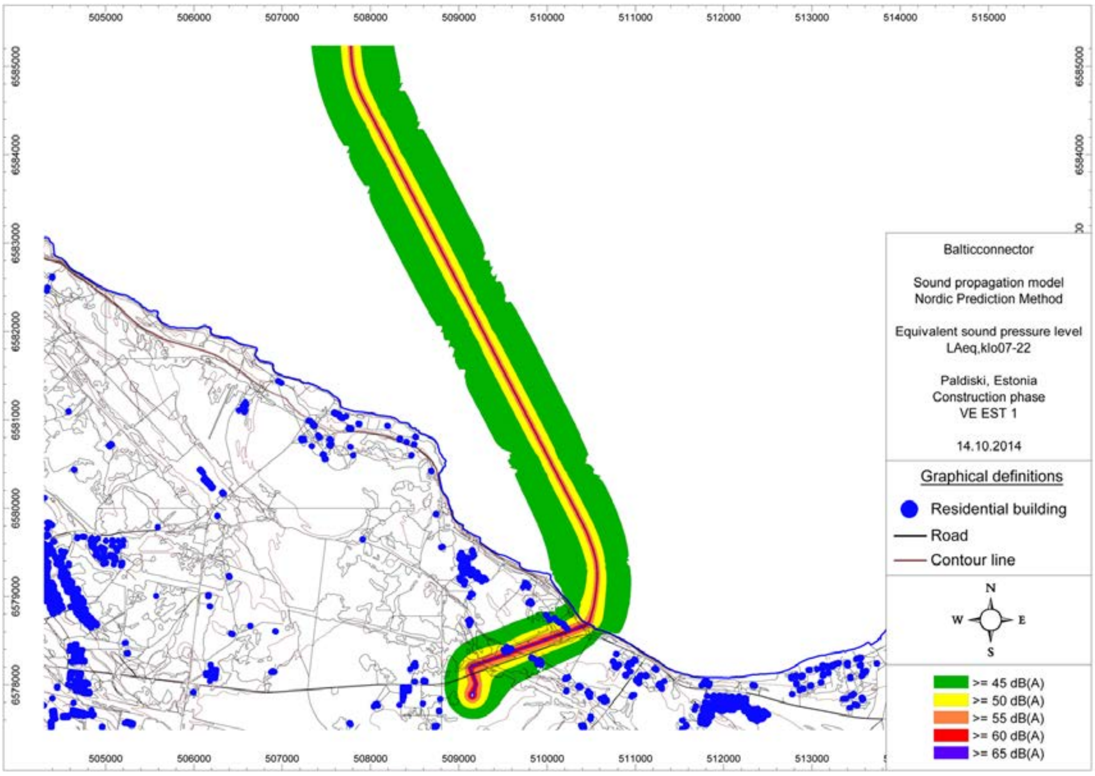


Figure 6-25. Noise modeling for the construction of ALT EST 1 routing alternative.

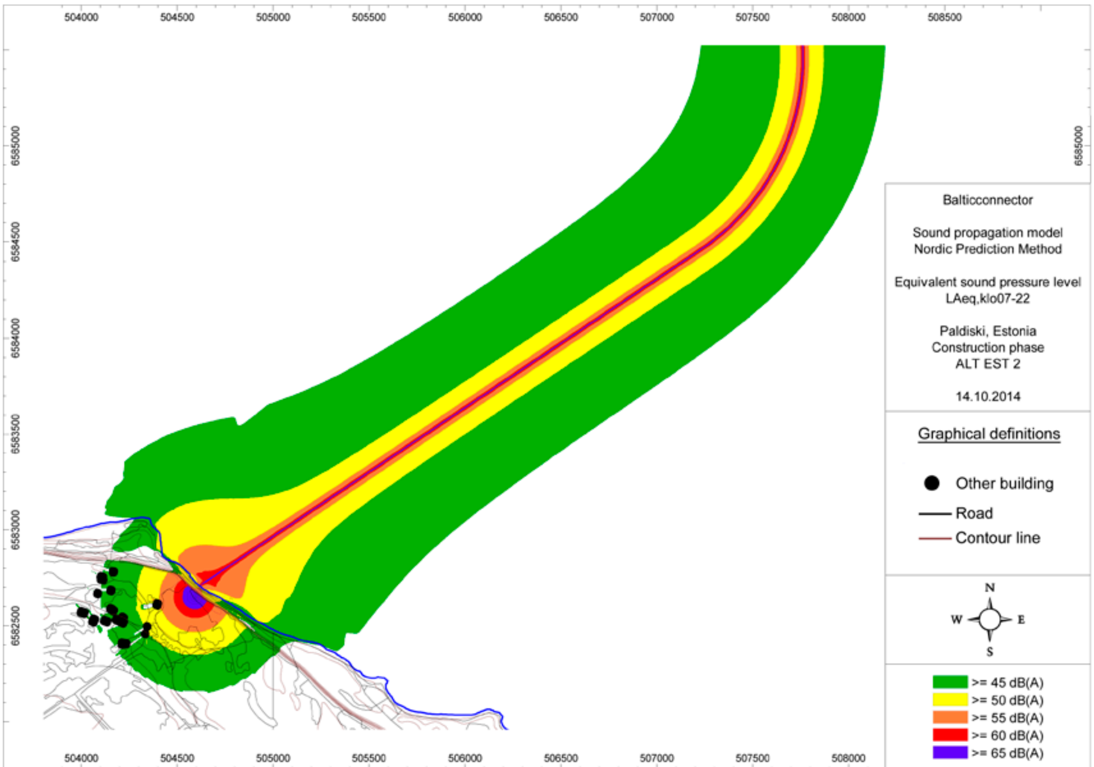


Figure 6-26. Noise modeling for the construction of ALT EST 2 routing alternative.

Summary of the significance of impacts

The daily guideline value for above-water and onshore noise impacts of 45 dB(A) (nature conservation areas, recreational areas) may be exceeded during construction in the construction area near the Natura 2000 site in the ALT EST 2 alternative. Some residential buildings will also be within the noise zone in the ALT EST 1 alternative. No significant differences regarding adverse impacts of noise were found on the basis of the calculations. Noise impacts during operation will be low.

Detailed measures to restrict the noise arising due to construction work will be given in detailed design. The building permit issued by Paldiski Municipality will enact these measures on the basis of valid regulations related to acceptable noise levels, including Regulation of Paldiski Town Council No 4 dated December 20, 2005 if valid at that time.

Table 6-25. Impact significance of noise. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	Moderate	**C** **Low**	**O** **No impact**	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.6.5 Impact on the natural environment

The impact assessment on the natural environment describes the impacts the project will likely or possibly have on flora, fauna, protected areas and objects, as well as on green network elements. Mitigation and compensation measures for impacts are described at the end of each sub-chapter and in the summary in chapter 9.

The two alternative locations for the mainland section of the Balticconnector gas pipeline are both located in natural areas where present human impact can be regarded low. Both ALT EST 1 at Kersalu and ALT EST 2 at Pakrineeme are currently mostly affected by road transport only. In the case of the ALT EST 1 alternative, this infrastructure is situated in parallel with the pipeline route and also crosswise (with Tallinn – Paldiski road) and intersecting minor roads in three locations. In the case of the ALT EST 2 alternative, an unpaved road with low traffic density near the landfall site is the only factor of existing human activity.

The impact of the mainland section of the pipeline on the natural environment can be divided into two phases – the construction period and the subsequent operation and maintenance period. The impact of the construction period can, in turn, be divided according to alternative construction methods – whether the pipeline will be taken to the mainland in a trench or by penetrating a microtunnel. Construction methods that damage natural environments the least have a lesser impact on natural communities and biotopes. Therefore the construction of an open trench will certainly have a greater impact than a closed method, which allows the pipeline to be brought to the mainland with very small modifications to the surface formations. Since there will be permanent or temporary damage to the natural environment in the case of both alternative routes, there are undoubtedly negative impacts on the natural environment. The planned width of the route construction area is 32 m, and it will cover sites of several protected plant and animal species.

6.6.5.1 Impact on flora

Sensitivity to impact differs by plant species – some species tolerate technogenic areas, while others only grow in untouched, natural areas. The direct impact zone of the ALT EST 1 route is limited by a route corridor 32 m in width. Five protected plant species grow within this corridor in eight sites. All of these are included in category III protected plant species according to the Nature Conservation Act. In addition, there is one site of a plant species included in protection category II (see section 5.2.8.1 above). Although all of the mentioned sites of plant species will be fully or partly destroyed during the construction activities, taking into account the overall state of the population in Estonia, it is important to cover here only the species with a few sites in Estonia and insufficient state protection. The impacts on these protected species are covered in section 6.6.5.3.

6.6.5.1.1 Impact of construction activities

The route on ALT EST 1 will be excavated as an open trench and soil will subsequently be place on top of the pipeline. This will disturb both the growing soil and water movement in it. In the best case scenario, it is possible to restore the original meadow flora in meadow areas, however, this is only possible in the case of successfully recreating both the physiochemical conditions and biological conditions important for the plants. Due to the existence and weaker recoverability of a higher number of protected species, more consideration is needed for the grassland vegetation. There are two valuable sites of dry grassland and one wet grassland vegetation. Dry, alvar grassland sites, including three protected plant species (see section 6.6.5.3) located close to the landfall point of the pipeline, will be greatly impacted by construction and will not recover without human help. The wet grassland vegetation site immediately alongside the compressor station, under and beside the high-voltage line, is remarkable for its diversity of plant species, including three protected species (see section 6.6.5.3), and it will most probably be destroyed by the construction of the pipeline according to the current plan.

It should also be noted that the construction of the route corridor will create new open habitat, and therefore the construction may help open-habitat plants to distribute.

The ALT EST 2 landfall site is defined as a point-site. The direct impact of construction activities around this point was assessed within a 50-m radius of this point. However, the area affected by construction work is much larger, because the landfall point is difficult to access and will certainly require access roads for construction activities. Therefore, a much larger area should be covered when assessing the impacts than this direct impact assessment currently discusses. The iImpact of ALT EST 2 on the upper slope of the klint is described in section 6.6.6.2.1.

No protected species have been registered within the ALT EST 2 construction site. However, unique and interesting habitats grow on the landfall site and 50 m toward the mainland. Construction will damage the plants at the landfall site and in its close vicinity, but generally the survival chances of plants can be regarded as good. Construction of s microtunnel will cause some vibration and possibly affect the water regime along the pipeline. The impact of these are difficult to predict. This, however, only applies to the penetrated section of the route. The further mainland section of the route (that is not covered in this environmental impact assessment), which will be constructed using conventional excavation methodd, will have a clearly destructive impact on flora.

6.6.5.1.2 Impact of operating and maintenance

After the construction of the pipeline and the subsequent soil restoration is complete, the gas pipeline corridor will be kept open by removing trees and bushes. This is the only impact element during operation and maintenance. Consequently, only herbs and shrubs can grow above the gas pipeline.

At ALT EST 2, the impact on flora during operation and maintenance will be similar to ALT EST 1, but the affected area will be much smaller at the landfall point if it is not required to be kept open by removing trees and bushes to mark entire microtunnel route.

Mitigation measures

On the ALT EST 1 Kersalu route, where the gas pipeline will be laid in a trench, the most critical impact is related to restoration of the growing soil. Unlike regular route restoration, which involves leaving it to recover naturally or sowing grass, in the ALT EST 1 meadow areas, the natural flora should be restored, and subsoil and water regime needed should already be during the construction phase. Fortunately, the more sensitive meadow area, an alvar grassland where sea thrift grows, is dry and will not be threatened by drought after construction. Nevertheless, the greenery on the route should be monitored during the following years, to avoid weed and other undesirable plants suffocating the natural plant formation of the area. Then, if needed, intervention can be carried out.

One important prevention measure to be considered in the case of the ALT EST 1 route is a minor positional shift to locations of lower impact on the natural environment. For this it would be sufficient to shift the landfall point and the rest of the route by 10 to 30 m toward the Tallinn-Paldiski highway within the valid thematic plan natural gas pipeline route corridor, as shown in Figure 6–27. In the case of such a solution, the following principle applies: human impact on nature is less the more the areas of different human impact overlap, lie next to each other or can be combined. Additionally, in more sensitive locations (see Figure 6–28) the impact area during the construction period should be reduced and the cumulative impact should be prevented when spatially planning further human activity in the area. In this way, it is possible to considerably reduce the impact on the natural environment in the Kersalu alternative.

6.6.5.2 Impact on fauna

While the impact on flora during the construction and maintenance of the gas pipeline is related to direct destruction or strong changes in the plant communities, fauna is influenced by the change in the habitat arising from it. Also, for some species the disturbances during the construction period are important.

Along the route of the Balticconnector ALT EST 1 in Kersalu and in its neighborhood, at a survey area of ca. 30 ha, a total of eight species of mammals have been registered (incl. two under protection) in 13 sites, 39 species of birds (incl. six under protection) as 359 breeding pairs, three species of amphibians (all under protection) in five sites, two species of reptiles (all under protection) in two sites, and 39 species of invertebrates (incl. nine under protection) in 66 sites. In total, there were 445 known sites of 91 animal species in the area surveyed.

The construction of the gas pipeline will have the greatest impact on forest-dwelling animal species, since forest habitats will never be restored along the route corridor. However, the corridor is quite narrow, about

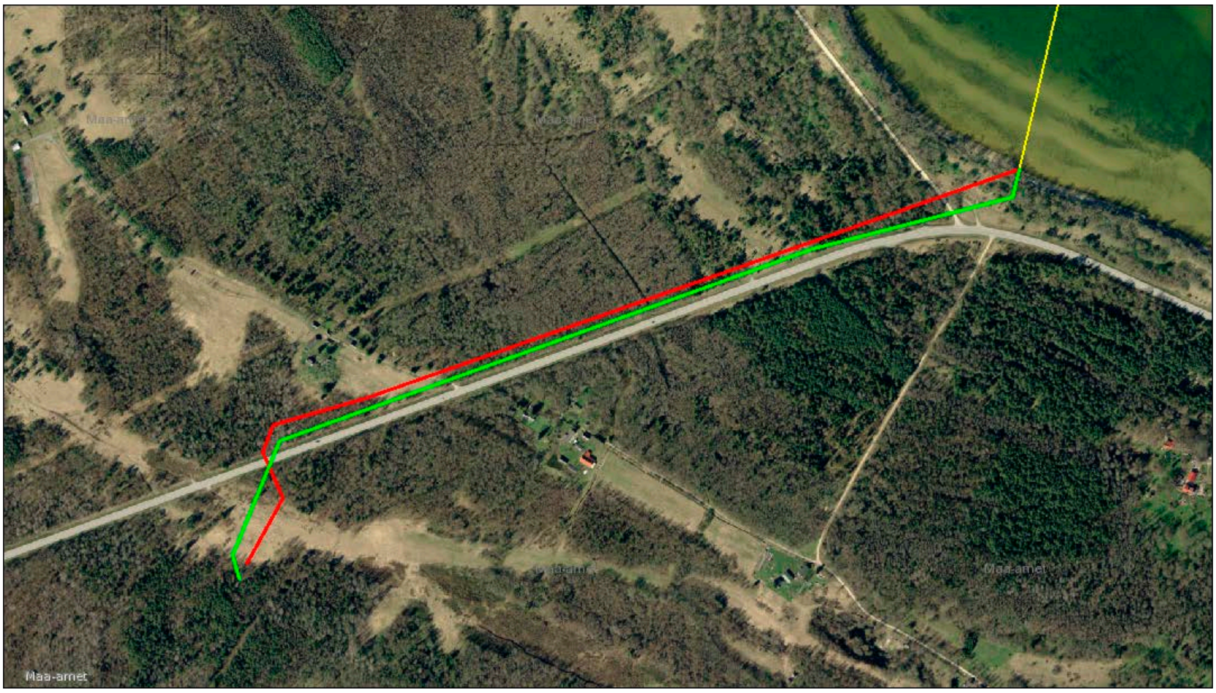


Figure 6-27. In order to reduce the impact of ALT EST 1 route (indicated by a red line in the figure) on the natural environment its location should be shifted witin the land-use plan towards Tallinn-Paldiski highway (the shifted route is indicated by green line).

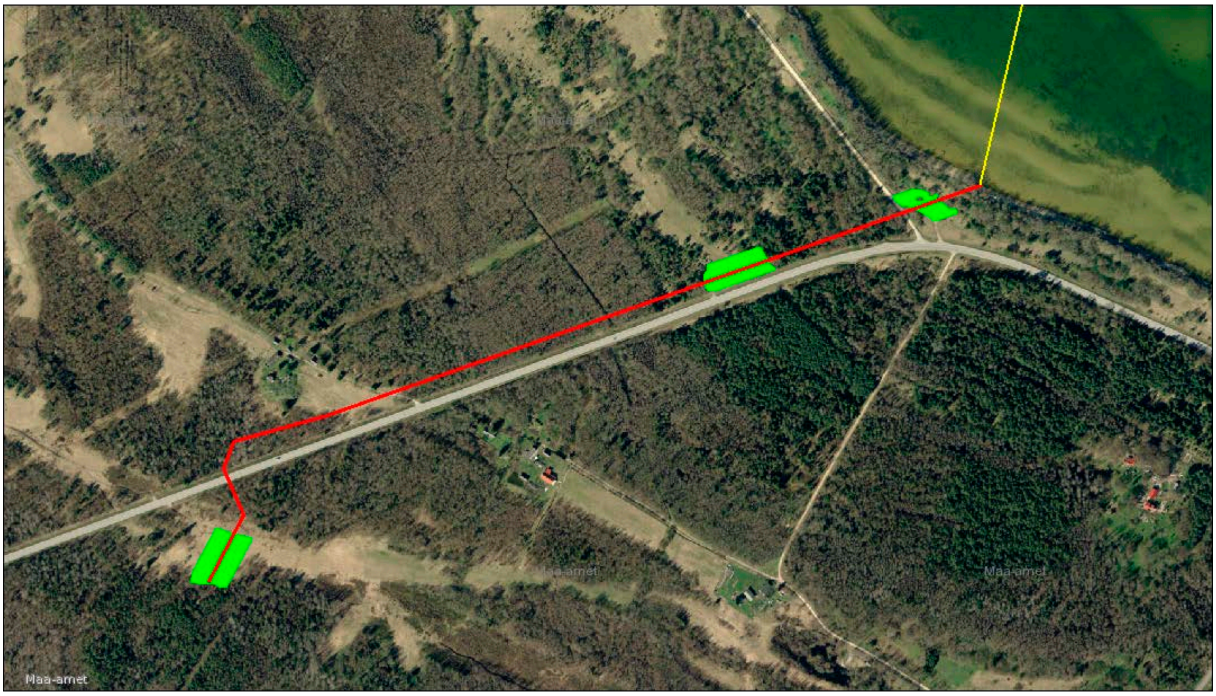


Figure 6-28. The most sensitive natural communities (indicated by green areas in the figure) on the Kersalu ALT EST 1 route (indicated by the red line in the figure).

32 m wide and totaling about 3 ha, and comparable to a forest ride, which normally does not have a great impact on forest biota.

The second important impact on the fauna in and around the ALT EST 1 route is the destruction of meadow habitats. This impact is most severe for the species living in unique plant communities, such as sea thrift formations on the sandy surface towards the sea. Also semi-campestral meadow formations will be destroyed within the route corridor. These meadows form habitats for several butterfly species, incl. protected ones such as *Phragmatobia luctifera* and large copper (*Lycaena dispar)*.

In the surroundings of the ALT EST 2 site in Pakrineeme, considerably fewer animal species have been registered: five species of mammals (incl. one under protection) in six sites, one protected reptile and 15 species of invertebrates (incl. three under protection) in 19 sites. According to habitat distribution, it can be predicted that also six protected bird species inhabit the area. In total, 27 animal species have been registered (or predicted) in 26 sites in the area of this alternative route.

6.6.5.2.1 Impact of construction activities

The impacts of construction activities in ALT EST 1 are expressed through habitat change and destruction, as well as disturbance during construction. Habitat change is irreversible for forest-dwelling species, such as the protected Red-breasted Flycatcher, *Formica* ants, the tree bumblebee and common carder bumblebee. Construction can directly destroy nests or dens of animals. Moreover, habitat destruction can destroy or alter characteristics of feeding or resting sites, or migration routes. Disturbance caused by noise or light pollution from the construction works can have negative impacts through possible behavioral changes.

s regards the destruction of nests on the ALT EST 1 route, the most sensitive species are the Red-breasted Flycatcher and other protected forest passerines of birds and *Formica* of invertebrates. All of the nests of these species on the pipeline route will be destroyed. While birds are safe during the non-breeding season and may be able to find nesting places in adjacent similar forests after the construction, all the anthills of *Formica* in the construction zone will be under impact.

Regarding the influences to feeding and shelter sites, the most sensitive species are such true butterflies (*Papilionoidea)* whose suitable habitats include mottled meadow landscapes. These species include e.g. purple emperor *(Apatura Iris)*, coppers *(Lycaeninae)*, blues *(Polyommatinae)* and skippers *(Hesperiidae*). Although at least 8 tracks of big game species cross the pipeline route, the construction of the pipeline evidently does not create a considerable obstacle for migration.

The construction of the pipeline can possibly have positive effects on fauna, because it will create an open habitat utilized by certain species of a variety of taxa. For example, forest birds or bats often feed in open areas or forest edges, and butterflies and other insects can benefit from the novel open habitats in means of feeding and shelter sites.

In the construction phase of the landfall site of ALT EST 2, the most important impact on fauna could be related to the construction of access roads and the section of the pipeline route on top of the klint. Since this impact assessment covers only the landfall site up to the top of the klint and the construction method of penetrating the pipeline through a microtunnel, the impact will be reduced to mainly noise and light pollution and vibration. Generally the impacts on fauna are lower in this construction method.

6.6.5.2.2 Impact of operating and maintenance

Considering that the impact of operating and maintenance is limited to keeping the route open and preservation of the required access roads, the impact on fauna is estimated to be insignificant.

Mitigation measures

The mitigation measures suggested for the protection of flora also to a great extent apply to fauna. In order to mitigate the impacts on forest fauna, it would be practical to shift the pipeline route within the land-use plan toward Tallinn-Paldiski highway as shown in Figure 6–27 above, so that the pipeline corridor and the road would form a continuous narrow belt-like structure, while preserving the integrity of the bounded forests. Special care should be taken in forest cuttings, freight-out and major construction works during the breeding season of birds.

For mitigation of the impact on invertebrates, it is advisable to use such plant species in restoration on top of the backfilling that are suitable as a feed for the caterpillars (for the coppers – e.g. sorrels; for the blues – e.g. vetches and clovers; for the skippers – e.g. *Gramineae,* reed bent and purple moor grass; for purple emperor – e.g. willows and great willow). Also it is advisable to leave smaller heaps of stone as shelters for common adder and viviparous lizard.

6.6.5.3 Impact on nature reserves and protected natural objects

The mainland section of Balticconnector covers areas of very different sizes in the two alternative routes. ALT EST 1 with its 32-m wide area directly under construction consists of ca. 3 ha, whereas ALT EST 2 with its construction zone (at the foot of the bluff) takes up presumably just ca. 0.1 ha. Also regarding the protected species involved, the alternatives are different. If the ALT EST 1 route in Kersalu does not cross any protected objects in an area according to the valid preservation regime according to environmental register, then the ALT EST 2 landfall site is situated in the Pakri Landscape

Reserve Area. However, it cannot be said that Kersalu route alternative does not actually cross any protected objects – the seaward section of the route is situated within the projected Pakri Nature Reserve, which has also been added to the environmental register. Therefore, both alternative routes impact on the protected natural object of an area. In addition, several habitats of protected species are found in the construction zone of both alternative routes. The ALT EST 1 area covers sites of five protected plant species and 17 animal species and the ALT EST 2 area covers sites of four protected animal species. None of the sites have been added to the environmental register because they have been discovered only during the studies carried out for the process of this environmental impact assessment.

The protected objects affected by the construction of the gas pipeline are the following:

1. The protection objective of **Pakri Landscape Reserve** Area is the protection of rare and scientifically valuable geologic objects (bedrock outcrops, drift lines, glacial boulders) and *formations* of living nature. The reserve has been created for protecting the local landscape – sea cliff, glacial boulders, drift lines and coastal meadows – and protected plant (common oak fern, military orchid, maidenhair spleenwort, large pink, *Hornungia petraea*) and animal species (Black Guillemot).
2. **Pakri Nature Reserve (under development)**, with the objective to protect (whole list look from EELIS, hereby given only those which occur at the pipeline route) the following protected habitats and species.

Table 6-26. Information about habitat/species at ALT EST 1 and ALT EST 2 areas.

Habitat/Species	ALT EST 1	ALT EST 2	Information
Vegetated sea cliffs (1230)		x	
Calcareous rocky slopes (8210)		x	
Siliceous rocky slopes (8220)		x	
Forests of slopes, screes and ravines (9180*)		x	
twayblade (Listera ovata)	x		Two sites
Military orchid (*Orhis militaris*)	x		One site
Lesser butterfly orchid (*Plantanthera bifolia*)	x		One site
Small pasque flower (*Pulsatilla pratensis*)	x		Two sites
Fumewort (*Corydalis intermedia*)	x		One site near construction zone.
Scarce fritillary (*Hypodryas maturna*)	x		Occurs potentially
Marsh fritillary (*Euphydryas aurinia*)	x		Occurs potentially
Black and Yellow Chaperon (*Phragmatobia lucifera*)	x		One site
Ants Formica ssp	x		Six sites
Bumblebees (*Bombus* ssp)	x	x	Twelve sites (ALT EST 1); six sites (ALT EST 2)
Common toad (*Bufo bufo*)	x		One site
Moor frog (*Rana arvalis*)	x		Two sites
Viviparous lizard (*Lacerta vivipara*)	x		One site
Corncrake (*Crex crex*)	x		Near construction zone
Arctic Tern (*Sterna paradisaea*)	x		Near construction zone
Common Shelduck (*Tadorna tadorna*)	x	x	Near construction zone (ALT EST 1); occurs potentially (ALT EST 2)
Little Ringed Plover (*Charadrius dubius*)	x	x	Near construction zone (ALT EST 1); occurs potentially (ALT EST 2)
Red-breasted Flycatcher (*Ficedula parva*)	x	x	Occurs potentially (ALT EST 2)
Red-backed Shrike (*Lanius collurio*)	x		Near construction zone
Sea thrift (*Armeria maritime elongata*)	x		Two sites
Large copper (*Lycaena dispar*)	x		One site
Common frog (*Rana temporaria*)	x		Two sites
Common adder (*Vipera berus*)	x	x	One site (ALT EST 1); one site near construction site (ALT EST 2)
Lesser Spotted Woodpecker (*Dendrocopos minor*)		x	Occurs potentially
European Nightjar (*Caprimulgus europaeus*)		x	Occurs potentially
Eurasian Wryneck (*Jynx torquilla*)		x	Occurs potentially
Northern bat (*Eptesicus nilssonii*)	x	x	One site in both ALT EST and ALT EST 2
Nathasius's pipistrelle (*Pipistrellus nathusii*)	x		One site

6.6.5.3.1 Impact of construction activities

The protected objects influenced by the construction of the natural gas pipeline are protected species and habitats in the case of both alternatives. The construction activities will mostly impact protected types of forest and forest habitats, such as those of the Red-breasted Flycatcher and *Formica* ants, because these will be destroyed irreversibly since no forest is allowed to grow back above the natural gas pipeline route. The Red-breasted Flycatcher is a protected category III bird species under the Estonian Nature Conservation Act, and the species is also included in Annex I to the Birds Directive. Also, of the registered sites in Estonia, the two situated on the Kersalu route are the only known sites within the city limits of Paldiski. However, only one out of the seven territories discovered in the breeding bird survey was situated in the direct impact zone of the pipeline. In addition, the forest habitat in the impact zone does not differ as a nesting habitat from the surrounding forests that will be left untouched by the construction activities.

Other protected species as regards the importance of impact are those inhabiting the meadow areas and whose existing sites will be destroyed either completely or partly, but also the sites themselves are very important here. Such species are the small pasque flower, sea thrift, *Phragmatobia luctifera* and large copper. Two sites of small pasque flower next to each other on the ALT EST 1 route will be destroyed completely by the construction of the gas pipeline because these are located directly in the earthwork zone. In the case of sea thrift, the sites will not be completely destroyed by the construction of gas pipeline on the Kersalu route. A smaller site is situated directly in the construction area of the gas pipeline. Three protected species – military orchid, twayblade and lesser butterfly-orchid are sufficiently protected in national populations and their sites on the gas pipeline route are not the most representative, the impact on a marshy grassland at the end of the ALT EST 1 route, where all of these species grow, needs separate consideration. It should also be noted that there is a site of fumewort (*Corydalis intermedia)* close to, but not intersecting with the construction area (see Figure 5–49).

Since ALT EST 2 is planned as a microtunnel by penetrating under all protected habitats, the habitats stay untouched.

It is generally clear in the case of both alternatives that structurally the impact on protected objects is considerably smaller if the natural gas pipeline is penetrated in a closed method since these objects would not be affected at all. For this, it would be necessary in the case of the ALT EST 1 route to penetrate the pipeline to a total length of ca 150 m (underneath the entire mainland part of planned Pakri Nature Reserve) and in the case of the ALT EST 2 route, ca 80 m (underneath the entire mainland part of the Pakri Landscape Reserve Area). Here, the vertical rise has not been taken into account, so the distances can be longer in reality. This solution can be considered as one possible prevention measure for the protected objects.

6.6.5.3.2 Impact of operation and maintenance

As already described above in the sections for flora and fauna (6.6.5.1.2 and 6.6.5.2.2), the most notable impact during operation and maintenance relate to keeping the gas pipeline open by removing trees and bushes. Certain open habitats can exist at the site of the gas pipeline, but the impact on forest habitats and species will be irreversible.

Mitigation measures

In the ALT EST 1 route, two sites of the protected small pasque flower next to each other will be destroyed completely by the construction of the gas pipeline according to the current plan, because these are located directly in the earthwork zone. Taking into account the great negative impact of human activity on this species in the whole northern Estonia, and especially on the Pakri Peninsula, the destruction of its habitats should be avoided by shifting the route away from the area of sites (see Figure 6–27) or by compensation through transplanting the population. The latter compensation method is simplified here by the fact that these sites are comparatively small and easily definable, so it should be possible to transplant these patches of topsoil, measuring 20 m² and 30 m², together with the plants (20 and 30 blooming plants) to a close proximity, to a habitat with suitable conditions. This activity should be carried out by a specialist in the field, and it should be done during the summer, after the plants have seeded, then the transplanting would also serve as seed distribution.

In the case of the protected sea thrift, a smaller site is situated directly in the construction area of the gas pipeline and it should be handled similarly to sites of the small pasque flower described above – if it is not possible to avoid damaging the habitat by shifting the route, the small pasque flower must be transplanted. Of the bigger site, a very important one in whole Estonia, more than a third would be destroyed by the construction of the gas pipeline (almost 4,000 m²). By shifting the pipeline route, as shown in Figure 6–27 above, it would be possible to decrease this area to a third, and if a strictly 12-m wide corridor would be used, this area can be further reduced to ca. 2,000 m². Another alternative would be to extend the population as a compensation. For this, all of the plants currently growing on the route should be transplanted to a meadow north of the route, near the northern border of the current site and also the conditions should be improved for the species in the area of a bushy alvar grassland bordered by the current site, improving its light conditions by cutting the brushwood.

There is a site for fumewort close to the construction site (see Figure 5–49). The site does not directly intersect with the construction area, but in order to prevent damaging this site and to avoid movement in the area, it should be marked before starting construction activities. This species blooms in early spring, therefore the site is clearly identifiable and can be marked in April-May.

Three protected species – the military orchid, twayblade and lesser butterfly-orchid – are sufficiently protected in national populations, and their sites on the gas pipeline route are not the most representative. Nevertheless, the impact on a marshy grassland at the end of the ALT EST 1 route, where all of these species grow, needs separate consideration. This grassland lying immediately alongside the compressor station, and under and beside the high-voltage line is remarkable for its diversity of plant species, and it will most probably be destroyed by the construction of the gas pipeline. Therefore, also here it would be sensible to shift the pipeline within the valid thematic plan route away from the meadow as shown in Figure 6–27. If this is not possible, after the construction of the gas pipeline, the excessive moisture regime should be restored on the meadow and the pipeline route should be covered with the same topsoil and turf that was dug out during construction. Also, within this grassland it would be advisable to use as narrow a construction area as possible, in order to cause as little damage as possible.

Anthills that would be destroyed during construction of the pipeline should be relocated. Relocation should be done so that the anthills connected by pathways are relocated on the same side of the pipeline, not on separate sides. Relocation and its preparation must be carried out by a *Formica* specialist, who has earlier carried out successful relocation. Also, to achieve the least construction impact, construction of the gas pipeline should be timed so that the wintering of *Formica* has not started. If relocation is left until it is too cold, the colonies will die during relocation.

It is generally important to bear in mind the required timing for operation and maintenance activities, so that it would be in compliance with the lifecycle of the protected species, both plants and animals, and disturb them the least. To this end, it is also certainly necessary to monitor the protected species at the locations of the natural gas pipeline route where mitigation or compensation measures have been taken, in order to find out the successful of the measures and to take any additional measures where required

Summary of the significance of impacts on flora, fauna and protected objects

ALT EST 1 area covers sites of five protected plant species (category III) and 17 protected animal species.

Sensitivity of the area is moderate. There are four very representative habitats in the project area, but their size compared to whole project area size is quite small. Nevertheless, as all of them will be fully or partly destroyed, impact should be taken as at least moderate, even though they are recoverable with mitigation measures. There exists one site of II category protected plant species that is at the same timeRed-Listed as endangered. Although that site does not occur directly on the pipeline route, but in its immediate vicinity, and despite more than 50% of the sites of that species being already protected in country, the impact still needs to be seriously assessed, because the number of sites registered in country is very small (24 sites), and site at the vicinity of project area is one of three sites only in Harju County. Also there is one other site of protected category III plant species that has only 22 known sites and the one at the pipeline area (of which almost one third will be destroyed) is very vital currently having more than 2,000 blooming plants.

The magnitude of change on the area will be moderate. As impact on three of the representative habitats is destructive and partly destructive for the fourth, and since impact is irreversible for one of those four habitats, the overall intensity of impact can be regarded as moderate. As the impact spatially on habitats is also moderate, despite low duration, overall magnitude of the change is still moderate. One site of the protected category II plant species could be destroyed in the area, and a large part of a very representative site of category III plant species will be destroyed, and this makes the impact intensity high. At the same time, the spatial extent of the impact will be moderate and its duration low, if soil, water and light conditions recover after construction phase.

The ALT EST 2 area is situated in the Pakri Landscape Reserve Area, where there are very representative habitats (also Natura 2000 habitats) and many plant species. The project area will impact a large part of habitats suporting plant species in the middle of the protected landscape area.

Sensitivity of the protected habitats is very high. Although there is no evidence that these protected species also grow in the project area (outside the protected landscape area), the suitability of habitats for them is high and therefore also the predicted impact is high.

The magnitude of change in the area will be moderate. Even in the case of microtunneling, the impact risk to habitats is still of moderate negative intensity. Although spatially the area impacted is not very large, impact duration (if it occurs even as habitat change due to water regime change) is high, and therefore the overall magnitude is at least moderate. The intensity of impact on plants is at least moderate due to the direct impact at the both endpoints of the microtunnel. Natural conditions in the area will not recover if any damage occurs.

For fauna, the impacts of the project are expressed through habitat change

Table 6-27. Impact significance on natural environment. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
Sensitivity of receptor		**Very high**	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
	Low	High	Moderate	Low	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	**C/ALTEST1 Moderate**	Low	No impact	Low	Moderate	High	High
	High	Very high	High	**C/ALTEST2 O High**	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.6.5.4 Impact on green network

There are no green network elements as defined by any thematic plans nor by the comprehensive plan of the City of Paldiski at the landfall point of ALT EST 1 at Kersalu.

The landfall point of ALT EST 2 is within the green network corridor (K9) of regional (national) importance as defined by the thematic plan, linking together two core areas (T9) of regional importance. The green corridor is a structure guaranteeing the coherence of the green network.

6.6.5.4.1 Impact of construction activities

The landfall point of the ALT EST 2 Balticconnector natural gas pipeline at Pakrineeme is constructed within a green corridor of regional importance (K9) - Pakri peninsula within the area of Pakri Landscape Protection Area. In order to transit the ALT EST 2 Balticconnector natural gas pipeline onto mainland a microtunnel will be used, which will have practically no impact on the main and most vulnerable element of the Pakri Landscape Protection Area - the Cambrian-Ordovician layer of Baltic klint, neither will the microtunnel construction impact the migration routes of flora and fauna.

There will be a temporary worksite of 10 000 m^2 for microtunneling constructed on the klint (*Ramboll 2014a*). Landfall point ALT EST 2 in Pakrineeme is located in the area of the adopted detailed plan of the Paldiski LNG terminal, in the property known as Male (see section 5.2.9.1, Figure 5-76). Under the adopted LNG terminal detailed plan, all the planned buildings, civil engineering work and infrastructure must be located within the determined building area. The exact position of the buildings, civil engineering work and infrastructure inside the determined building area, will be specified in the building design documentation.

The impact of construction of the worksite will probably have no significant impact on the green corridor. During the construction phase, the function of the green corridor can be impacted by construction work and transport (impacts of noise and visual disturbances on the fauna). The impacts on the green corridor will be short-term in nature and be restricted to a small land area.

Construction activities will have no significant impact on the green network.

6.6.5.4.2 Impact of operation and maintenance

If the ALT EST 2 natural gas pipeline is constructed in Pakrineeme, there will be a cumulative impact deriving from the construction of the LNG terminal, which would be the first larger structure in the natural landscape, excluding existing and constructed wind generators on the peninsula. At the same time, the green network and its coherence in the area of the LNG terminal has been addressed in the detailed plan of the mainland part of the LNG terminal (*Sweco Projekt 2014*)., Deriving from the detailed plan it can be concluded that the coherence of the green network with the surrounding areas is guaranteed. The impact on the functioning of the green network can therefore be concluded as insignificant.

Summary of the significance of impacts

In conclusion, the impacts on the functioning of the green network for both alternatives are assessed as insignificant.

Table 6-28. Impact significance on the green network. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	Moderate	**C** **Low**	**O** **No impact**	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	Highe	High	Very high	Very high

6.6.6 Impact on the socio-economic environment

6.6.6.1 Impact on tourism, recreational conditions of the region and economy

6.6.6.1.1 Impact of construction activities

The Kersalu area in Paldiski is sparsely populated, and to date the coastal area is not used intensively. The area is used randomly for recreation on the beach, mostly during the spring and summer. Impacts arising from construction activities are of a short-term nature and restricted to a small land area. Construction activities pose no significant impact on the recreational conditions of the Kersalu area, if construction gtakes place when beach is not used.

There are no tourist sites in the immediate proximity of the ALT EST 1 area in Kersalu, therefore construction poses no significant impact on tourism.

The area of the ALT EST 2 landfall point in Pakrineeme is located away from human settlements – the region is developing into an area of industrial land use. At the same time, the area is part of the Pakri Landscape Protection Area, and a hiking trail is situated on the top Pakri klint scarp. The Balticconnector natural gas pipeline ALT EST 2 landfall point will penetrate the klint via microtunnelling. Since there is a plan to use microtunnel pipeline penetration at the ALT EST 2 landfall point, implementation of this alternative will have minimum impact on the recreational activities of local residents and tourists during construction phase. This construction method does not impact usage of the hiking trail. There will be a temporary worksite of 10 000 m² for microtunneling constructed on the upper slope of the klint. The exact position of the worksite will be specified with the building design documentation. It is not yet known how far from the shoreline and from the hiking trail the temporary microtunneling worksite will be situated. The impact of worksite construction will probably have no significiant impact on use of the hiking trail. If needed, during the construction phase, the hiking trail can be diverted. The primary environmental impacts on the use of the hiking trail are related to noise arising from construction activities (noise and/or vibration). However, these impacts are of a short-term nature and restricted to a small land area. Construction activities pose no significant impact on recreational conditions of the ALT EST 2 area in Pakrineeme.

The closest intensively used swimming beaches in the area are the Lohusalu beach (located directly 4 km from the ALT EST 2 landfall point as the crow flies) and the Kloogaranna beach (located approximately 2 km from the ALT EST1 landfall point. Both of those swimming beaches are located on the other side of Lahepere Bay. The construction of the Balticconnector pipeline will not visibly disturb the views over the sea from the beaches towards Pakri Peninsula, because the distance is too long. Changes in water quality during construction are addressed in section 6.5.2. Concentrations of floating material from the work area (2–5 days after work) are very low. Most of the material lifted intothe water column will settle in the immediate work area.

6.6.6.1.2 Impact of operation and maintenance

There will be no negative impacts on tourism and recreational conditions during operation and maintenance of the Balticconnectorpipeline. There will be no restrictions on using the beach for swimming or using the hiking trail after the Balticconnector natural gas pipeline has been constructed. Views from a distance from the closest swimming beaches will remain unchanged (see also section 6.6.6.3.2).

The Balticconnector project will cause significant overall positive economic impacts at a national level. An extensive integration of the energy networks of Estonia and the Baltic Sea Region is important in terms of security of supply and providing energy security. It is also important from the standpoint of supplying energy to the residents of Estonia at the lowest possible price. Admittedly, the natural gas pipeline will not create additional jobs in Paldiski, but new users of gas may create jobs elsewhere in Estonia, as their confidence in using natural gas as their main energy source will probably grow. So far, natural gas has been often one of the cheapest energy sources, but many companies who need to have guaranteed energy supply have not dared to use it, as Russia has shown an ability to turn off the supplies in the event of political conflicts (this has been painfully visible in the case of Ukraine).

Impacts on the economy of the City of Paldiski from the Balticconnector natural gas pipeline are low. No new jobs will be created permanently. Later in the case of both alternatives, some local people may gain employment as the gas supply security will grow, but this is an indirect impact even if it exists. So, in the local municipality context, the positive economic impacts are not visible, but in whole Estonian context there will be a positive economic impact as gas supply in Estonia is secured compared to the current situation where the country depends on natural gas of Russian origin.

Summary of the significance of impacts

The implementation of either alternative, the ALT EST 1 or the ALT EST 2, will have minor impacts on recreational conditions and tourism during construction and during operation and maintenance because:

- There are currently no intensely used tourist sites and recreation areas in the Kersalu ALT EST 1 area.
- Since there is a plan to use microtunneling for the natural gas pipeline at the ALT EST 2 landfall point, this alternative will not impact the recreational activities of local residents or tourists during the construction phase, as this construction method will not damage the hiking trail and will have minimum impacts on tourism. The operational phase will not impact use of the hiking trail.

The Balticconnector project will cause a significant overall positive economic impact at a national level. The project has a long-term duration (the planned lifecycle of the pipeline is long – about 50 years).

The impact of the Balticconnector natural gas pipeline will be remarkably positive mostly in the context of Estonia since it will increase the security of supply for all the gas users operating in Estonia, and reduce the current complete dependence on gas imported from Russia. Construction of the Balticconnector natural gas pipeline will also implement national priorities according to the valid national spatial plan "Estonia 2030+". Both alternatives will have an equal overall positive impact on the state of Estonia and the business opportunities in this country.

Table 6-29. Impact significance on tourism and the economy.

Impact significance		Magnitude of change								
		Very high	High	Moderate	Low	No change	Low	Moderate	High	Very high
Sensitivity of receptor	Low	High	Moderate	**Low**	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	Moderate	Low	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.6.6.2 Impact on land use and land use planning

Construction of the Balticconnector natural gas pipeline will implement international energy and environmental objectives, and falls in line with the strategic objectives of the valid national spatial plan "Estonia 2030+". The proposed project is also in line with the thematic plan of the comprehensive plan of Paldiski titled "Location of the category D natural gas pipeline", and with the LNG terminal plans with regard to ALT EST 2.

The valid comprehensive plan of Paldiski addresses Balticconnector ALT EST 1 as a prospective residential construction area. New residential land has been earmarked in the area between the Vana Tallinn highway, Jaani road and Tallinn Paldiski highway. It has been proposed to construct the ALT EST 1 Balticconnector natural gas pipeline within the sanitary protection zone of the Tallinn Paldiski highway (National road 8), which is designated as a protective vegetation zone in the valid comprehensive plan.

After the thematic plan titled "Location of the category D natural gas pipeline" was adopted in 2011, a detailed plan of the Vanaaseme property was approved on June 26, 2014 for the area in the Kersalu near the ALT EST 1 landfall point, permitting construction on 15 residential lots (single family houses). As the thematic plan titled "Location of the category D natural gas pipeline" was adopted prior to the aforementioned detailed plan, it can be assumed that the developer of the detailed planning area had the necessary information regarding the planned construction of the Balticconnector natural gas pipeline. The pipeline will not impact real estate value, but if housing is built before the pipeline, the construction of it may impact new residents (construction-related disturbances, including the temporary closure of access roads). However, these impacts are moderate or low because the proposed pipeline is at an approximate distance of 100 m from the closest planned housing area, and therefore there are no direct conflicts of the Balticconnector natural gas pipeline and the detailed plan solution of the Vanaaseme property. The pipeline may, to some extent, impact the use of the beach and the image of the area as an environmentally-friendly living area. Nevertheless, these impacts cannot be considered to be significant over the long-term because the construction phase of the pipeline is of a short duration.

Landfall ALT EST 2 in Pakrineeme is in line with the principles described in the thematic plan titled "Location of the category D natural gas pipeline", and with plans and projects related to the LNG terminal development (See also chapter 5.2.9.1).

There will be temporary a worksite of 10 000 m² for microtunneling constructed on the upper slope of the klint. Landfall ALT EST 2 in Pakrineeme is located in the area of the adopted detailed plan of the Paldiski LNG terminal, in the property known as Male (see section 5.2.9.1, Figure 5–76). The exact size, shape and position of the shaft of the hydraulic jack and the construction site of the microtunnel of ALT EST 2 in Pakrineeme is not specified in pre-FEED report (*Ramboll 2014a*). The exact position of the shaft and construction site of the microtunnel inside the determined building area of the LNG terminal detailed plan (see section 5.2.9.1, Figure 5–76) will be given in conjunction with the building design documentation.

In summary, it can be concluded with regard to both alternatives that implementation of the Balticconnector will not affect the valid plans. If the alternatives are compared from the aspect of impact on the detailed plans, ALT EST 2 in Pakrineeme may be preferable under the assumption that the Balticconnector landfall point is connected to the compressor station located in the LNG area. In contrast, the detailed plan for a residential area has been approved in the close proximity to the ALT EST 1 area, and the comprehensive plan of the City of Paldiski also grants permission for the planning of other residential areas near the ALT EST 1 area. This means the impact on the plans and planned environment is bigger there, and also brings with it an indirect impact on using the Kersalu beach.

The Balticconnector onshore natural gas pipeline in ALT EST 1 will pass through total of eight land units near the compressor station. Of these, four are separate plots of land that continue to be owned by the state, and three are privately owned plots of land designated as profit yielding land, and one cadastral unit is land designated for transport.

The ALT EST 2 landfall point is located in a cadastral unit designated as commercial land. Assuming that ALT EST 2 is connected to the gas infrastructure of the planned LNG terminal, the impacts related to land ownership of will be lower in the case of ALT EST 2 than in ALT EST 1. The impact of ALT EST 2 can therefore be assessed as low, and the impact of ALT EST 1 as moderate.

6.6.6.2.1 Impact of construction activities

With the landfall point of ALT EST 1 natural gas pipeline in Kersalu, natural woodlands alternate with alvars around the onshore part from the point of landfall until the compressor station. The onshore part of the ALT EST 1 pipeline – from the landfall point until the compressor station – is surrounded by three groups of existing residential buildings:

- Tallinna mnt 51, 51a and 53 properties – distance from the nearest residential building to the natural gas pipeline is approximately 62 m;
- Tallinna mnt 56/ Korka and Vanaranna tee 37 properties in Keila Parish – distance from the nearest residential building to the natural gas pipeline is approximately 90 m;
- Vana Tallinna mnt 5 property – distance from the nearest residential building to the natural gas pipeline is approximately 80 m;

The primary environmental impacts on the housing that exists or will be built in near future are related to noise arising from construction activities (excavation) (and/or vibration). During construction, it may also become necessary to temporarily close certain road sections. This will have a moderate impact on traffic in the area during construction. Construction of the ALT EST 1 pipeline in Kersalu will also restrict the opportunities of local residents to use the beach primarily during the construction period.

The ALT EST 1 Balticconnector natural gas pipeline in Kersalu will be laid within the Tallinn-Paldiski highway sanitary protection zone in a construction area of 32 m in width. After construction, the land area will be leveled and landscaping will be restored, and the constructed gas pipeline will not be visible from the highway. In general, the highway sanitary protection zone is a suitable area for instaling utility networks – the area next to the highway is unsuitable for establishing new residential areas and recreational areas.

Overall, construction activities may indirectly impact a small number of existing residents (above all due to noise and excavation work that disrupts traffic) and use of the beach (during construction), therefore the negative impact, depending on the time of construction of the pipeline, is either moderate or low. The duration of the impact of construction in the City of Paldiski is low and short-term in the case of both alternatives. The impact on beach use can be mitigated if construction work takes place during a period when the sea is not used for swimming. The impact of ALT EST 1 would also be lower if the gas pipeline is constructed before housing is constructed on the Vanaaseme property.

ALT EST 2 is located away from existing and planned housing, and there will be no impact on local residents during construction. Therefore the impacts of construction in that area are almost non-existing for the people living in Paldiski, but it will have minimal impact for those using the hiking trail.

6.6.6.2.2 Impact of operation and maintenance

Under Government decree "Gaasipaigaldise kaitsevööndi ja D-kategooria gaasipaigaldise hooldusriba ulatus" (*RT I 2002, 58, 367*), the protection zone of the category D gas pipelines with a diameter of over 500 mm – is 10 m, and the maintenance strip width is 6 m. An usufruct will be established for the route. The protection zone of the natural gas pipeline is 10 m to either side of the axis of the pipeline according to the thematic plan titled "Location of the category D natural gas pipeline" (*K-Projekt 2012*). Activities prohibited in the protection zone area according to the Gaseous Fuel Safety Act Section 10 (2) (*RT I, 29.06.2014, 26*) include cultivation of trees and making a fire. The work area outside the usufruct area will be returned to the landowner's use after the construction of the natural gas pipeline. Trees may be planted or natural regeneration allowed in the work area returned. The use or storage of explosives is not permitted in the vicinity of the natural gas pipeline. Construction is not permitted along the natural gas pipeline without the permission of the pipeline owner and neither is the storage of timber or other material. Excavation work may not be carried out within 10 m on either side of the axis of the pipeline from the natural gas pipeline without separate authorization. Pipelines may only be crossed by heavy forestry machines at the reinforced crossing points provided for the purpose. The placement of crossing points will be agreed case-specifically during pipeline design.

Dredging, anchoring or movement with lowered anchor, chain, log, trawl or net is not allowed in the protection zone of a gas pipeline laid in a water body.

Summary of the significance of impacts

In summary, with regard to both alternatives it can be concluded that the implementation of the Balticconnector project implements land use objectives provided in prior plans.

If alternatives are compared from the aspect of impact on the land use and planning, ALT EST 2 in Pakrineeme may be preferable to some extent. Above all, it is a positive solution under the assumption that the Balticconnector landfall point is connected to the compressor station located in the LNG area. However, the social impact of ALT EST 1 in the local context remains higher than that of ALT EST 2 because of existing residential buildings. The possible impacts of building the Balticconnector in Paldiski on the nature and tourism are described in other parts of the report.

Table 6-30. Impact significance on land use. C = construction phase, O = operating and maintenance.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	Moderate	**Low**	**O No impact**	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.6.6.3 Impact on the landscape and cultural heritage

6.6.6.3.1 Impact of construction activities

The impact of construction activities on the pipeline depends on the alternative construction options – if the pipeline is brought to the mainland using so called bottom pull method (in a pipe trench, ALT EST 1, see section 3.4.6) or by using a microtunnelling method (ALT EST 2, see section 3.4.6). At the landfall alternative ALT EST 1 in Kersalu, where the pipeline would be brought to the mainland by the bottom pull method, the landscape of the shore would change significantly in the 32- m zone, because the section of the buried klint scarp would be trenched and the 8-m thick limestone (hard rock) layer (see section 6.6.1.1) would need to be penetrated. As this is a low klint scarp, which has not been defined as valuable landscape by the thematic plan, the visual impact on the landscape can be concluded as moderate and mostly limited to the construction period. Kersalu is not an intensely used vacation area, and construction activities will impact a small number of local inhabitants. In conclusion, it can be said that the impact of construction activities on landscape change on the klint at the landfall of ALT EST 1 is not significant, is of short-term nature and the impacts will be restricted a small land area.

Alternative ALT EST 1 planned at Kersalu will include a more than 1- km long mainland section of the pipeline running parallel to the Tallinn Paldiski highway through forest and three alvar areas. Forests in the Kersalu ALT EST 1 area are of medium and low value (*Entec Eesti OÜ, 2014*). Alvars are a part of cultural heritage landscapes.

The ALT EST 1 alternative will be constructed within the Tallinn Paldiski highway protection zone as the construction area of the pipeline is 32 m wide. The ALT EST 1 alternative will be constructed through three alvar areas along a total length of 260 m. The total area of alvars impacted during construction is approximately 800 m^2.

A temporary access road will also be constructed in the work area. In woodland areas, trees will be cut from the work area. Alvar and forest associations within the 32-m wide construction zone will be felled and mowed, although the grassland will later be restored, and the forest areas will possibly recover naturally in time (except over the width of the protection zone of the natural gas pipeline).

Construction will take place in stages. In areas where the route passes from an open landscape area into a forest, the 32-m wide treeless zone may be visible at a great distance in the landscape. As tree removal will take place well in time before construction commences and the growth of a new forest is a slow process, the treeless route during construction will have quite a long-term, albeit temporary, impact on the landscape. Views of the treeless route will only open up from certain view points, and the impact on landscape will be local. In sections where the routing is planned to pass across a forest island, the removal of trees will impact the views and bordering of the open alvar (meadow).

Forest areas and alvars along the natural gas pipeline route will turn into worksites during construction. This will be visible in the landscape as trenches, site machinery and piles of soil. Excavated soil will be deposited by the trench during construction (see Chapter 3.4.7). The piles will be low. Following installation of the natural gas pipeline, the trench will be filled with the excavated soil, and the damage to landscape will be short-term. The impacts on the landscape values of the areas will be moderate and temporary.

The mainland part of the ALT EST 1 Balticconnector natural gas pipeline at Kersalu intersects with the Vana Tallinn highway, which is a gravel road preserved in its original form. The intersections with other roads will be constructed by laying the natural gas pipeline under the road in a separate drilled steel protection pipeline. Detailed technical design for the intersections will be approved by the competent authorities. After completion of the construction work, the drainage and roads will be restored to their former shape and quality. The existing historical Vana-Tallinna highway will presumably not be damaged – the road will not be made wider or narrower as a result of construction work. If any historical elements (border stones, road markings) are found near the Vana Tallinn highway during the construction work, then their value will be assessed in cooperation with the National Heritage Board and Estonian Road Administration, and Paldiski Town Government will be notified of the value of historic road markings.

The impact of ALT EST 1 pipeline during the construction phase in parallel to the Tallinn Paldiski highway is local, short-term and temporary, and therefore it would not significantly impact the landscape and cultural heritage.

The alternative ALT EST 2 at Pakrineeme is assessed as a point object constructed on a valuable landscape of national importance – Pakri Peninsula within Pakri Landscape Protection Area.

The landfall of the alternative ALT EST 2 will be constructed using a microtunneling method, which will have minimal impact on the main and most vulnerable element in the Pakri Landscape Protection Area – the Cambrian Ordovician layer of Baltic klint and bank forests. Therefore construction activities will have no significant impact on the valuable landscape of Pakrineeme.

There will be a temporary worksite of 10,000 m^2 for microtunneling constructed on the upper slope of the klint. The exact size, shape and position of the shaft of the hydraulic jack and the construction site of the microtunnel of ALT EST 2 in Pakrineeme is not specified in pre-FEED report (*Ramboll 2014a*). The exact position of the shaft and construction site of the microtunnel inside the determined building area of the LNG terminal detailed plan (see section 5.2.9.1, Figure 5–76) will be given in conjunction with the building design documentation. It is not yet known how far from the shoreline and from the hiking trail the temporary worksite for microtunneling will be situated. The impact of construction of the worksite will probably have no significiant visual impact on the landscape. If required, during the construction period, the hiking trail can be diverted. Visual impacts on the landscape change are short-term in nature, and the impacts are restricted to a small land area.

6.6.6.3.2 Impact of operation and maintenance

The impacts on the landscape will mainly be low during the operation of the natural gas pipeline. In open landscapes, the impact on landscape caused by the completed natural gas pipeline will be low, or there will be no impacts on landscape. In open areas, the only visible signs of the pipeline will be the signposts indicating its location. Clearcutting carried out during construction in forested ranges will, however, also have an impact on views in open landscapes in many areas. Views to the alvars can be seen by people using the Tallinn–Paldiski highway. Views from a distance will remain unchanged.

Natural gas pipelines have a moderate impact on landscape in sections where the route passes through a forest area. The landscape impact of the treeless zone will be local. A total of 20 m in width, the treeless zone will be visible from certain viewing points. In extensive open landscapes, the treeless zone may be visible at a great distance in the landscape. The impact will be more significant immediately after construction since the worksite area will remain treeless for a long time. Once the trees in the worksite area have grown, the 20-m protection zone will be visible in the landscape.

After completion of construction work the flattened klint will be restored to its former shape, and the area will be evened and greenery restored. Views from a distance to the klint will remain unchanged, partly where the forest is cut, the view to the sea will be opened.

Once completed, the natural gas pipeline will not have a significant impact on the landscape value of the areas.

If ALT EST 1 pipeline is constructed in parallel to the Tallinn Paldiski highway, roadsides and restored alvar areas must be kept open. Trees and bushes will be removed from the alvar as needed, and mowing is done at least once a year during autumn or summer, not earlier than July 15. The use of fertilizers and biocides, as well as the introduction of plants not specific to the area, is forbidden. Maintenance also includes roadsides in order to prevent the growth of brush. If roadsides are mowed at least once a year and the mowed grass is removed, then it will be possible to increase the diversity and blooming of local plants, and to increase the area of the natural association, which has a positive impact.

The landfall area of the ALT EST 2 is located in the Paldiski Landscape Protection Area, and it is in the immediate vicinity of a hiking trail. Since the pipeline would constructed through a microtunnel in the section of ALT EST 2, the assumed landfall point of the Balticconnector pipeline will not be visible to people using the hiking trail, and thus the impact of the gas pipeline on the landscape will be minimal. The views from a distance will not change in relation to construction, but a cumulative impact can be addressed when the landfall is linked to nearby infrastructure, i.e. the LNG terminal, the construction of which will significantly change the view of Pakri Peninsula. The terminal is the first larger structure in the natural landscape, excluding the existing and planned wind generators located there (*E-Konsult 2013*). The visual cumulative impact of constructing the LNG terminal and Balticconnector pipeline will be moderate for users of the recreation area.

Summary of the significance of impacts

The impacts on landscape during construction will be higher than the impacts during operation.

In comparing the two alternatives, ALT EST 2 is preferred due to its impact on the valuable landscape and cultural heritage, as a microtunnel is safer for the environment and has a smaller impact on the landscape.

As regards ALT EST 1 at Kersalu, the visual impact on the landscape will be moderate and mostly limited to the construction phase. In the remaining mainland sections, construction of the Kersalu pipeline will have no significant impact on the landscape and cultural heritage. The impact of ALT EST 1 can be mitigated if the alvar areas are restored.

ALT EST 2 will have a moderate negative impact as a cumulative impact together with the construction of the LNG terminal on the use by local residents of a hiking trail located in a recreational area of national importance. But the main influence there does not come from Balticconnector, but from the LNG terminal.

Table 6-31. Impact significance on the landscape and cultural heritage.

Impact significance		Magnitude of change								
		Very high	**High**	**Moderate**	**Low**	**No change**	**Low**	**Moderate**	**High**	**Very high**
Sensitivity of receptor	**Low**	High	Moderate	Low	Low	No impact	Low	Low	Moderate	High
	Moderate	High	High	Moderate	**Low**	No impact	Low	Moderate	High	High
	High	Very high	High	High	Moderate	No impact	Moderate	High	High	Very high
	Very high	Very high	Very high	High	High	No impact	High	High	Very high	Very high

6.6.6.4 Impact on human health and well-being

6.6.6.4.1 Impact of construction activities

During the construction phase of the natural gas pipeline, there will be an impact on people located and living near the construction area. Operation of construction equipment will generate noise, dust and air pollution in the construction area. Road traffic will increase during the transportation of building materials – on the Tallinn road through the City of Paldiski up to the construction area of both alternatives. There will be vessel traffic in the open sea and close to the shore in the working area of the gas pipeline route.

In order to lay the pipeline on sea bottom properly, up to 985,933 m³ of backfilling is needed. This will be distributed over the distance between Estonia and Finland. It is foreseen that sea transport will be used to ship backfill material, thus the load on road traffic will be minor and last a short time. The onshore pipeline pipes will be transported by ship or truck. Since there is only 1.3 km of onshore pipeline, only 110 pipes are needed. Their transport does not need any special conveyance. During construction, the traffic load will somewhat increase, but by taking into account the speed of pipelaying (0.5–1.5 km per week), the increase will be evident during some weeks.

The impact on ambient air is covered in section 6.6.3 and impact of noise in section 6.6.4.

Degradation of human well-being to some extent is temporary, within the limits of the section of the gas pipeline being built both on the mainland and at sea, when a traffic or moving restriction is enforced.

The potential negative impacts on people referred to above are temporary, and can be reduced by the organization of construction activities and engineering methods.

Overall, the impact is minor.

6.6.6.4.2 Impact of operation and maintenance

The natural gas pipeline itself will have no impact on human health and well-being. During the repair of a section of the gas pipeline, impacts similar to those of the construction phase can appear in that particular area, but this is limited to the duration of repair work and will not affect people outside the area concerned. Overall, the impact is non-existent.

The risks of operating and maintenance of the gas pipeline for people are covered in section 6.9.

6.6.7 Impact on the technical infrastructure

The construction of the Balticconnector natural gas pipeline will have no impact on the technical infrastructure if the laws of the Republic of Estonia, applicable standards and requirements issued by authorities are complied with during the construction and operation of the category D natural gas pipeline.

6.7 Natura assessment

Natura 2000 is a European network of nature conservation areas, which was established under the Habitats Directive issued in 1992 (92/43/EEC) in order to protect and conserve endangered valuable species and habitats in Europe. The Natura 2000 network consists of habitats in Member States as defined by the Habitats Directive, and bird areas as defined by the Birds Directive (79/409/EEC).

Appropriate assessment of Natura 2000 sites has been conducted according to the Habitats Directive Article 6(3). Assessment is based on the instruction material issued in 2013 titled "Juhised Natura hindamise läbiviimiseks loodusdirektiivi artikli 6 lõike 3 rakendamisel Eestis" ("Instructions for Conducting Assessment when Applying Article 6(3) of the Habitats Directive in Estonia") (*KeMÜ 2013*). The assessment only derived from species and habitats protected in the potentially impacted areas.

The locations of valuable habitat types listed in Annex I to the Habitats Directive on the Pakri Habitats Directive Site were defined based on the map layers of Natura habitats issued by the Estonian Environment Agency *(EELIS 2013*), as well as on the results of seabed habitat modeling funded by the Environmental Investment Centre (*KIK*) and conducted by the Estonian Marine Institute, University of Tartu within the project of the Estonian Fund for Nature (*ELF*) "Collecting Nature Conservation Data, Including Modelling of Habitats in the Territorial Sea, for the Planning of Estonian Sea Areas" (*TÜ Eesti Mereuuringute Instituut 2014*). Assessment also considers the results of mainland biota and valuable habitats research conducted in 2014 (*Klein 2014*).

In addition to the aforementioned sources, the appropriate assessment of Natura 2000 also uses the following sources of information:

- EU Habitat (92/43/EEC) and Bird Directive (2009/147/EC);
- modeled results of the spreading of sediment (i.e. clouding);
- modeled results of the spreading of noise (including underwater noise);
- results of fieldwork conducted within the project (results of research on fish fauna, birds, seabed biota etc.);
- Pre-FEED report (*Ramboll 2014a*) etc.

6.7.1 Information on planned activities

Balticconnector is being developed by Gasum Corporation. The appropriate assessment of Natura is a part of the EIA report of Finngulf LNG Balticconnector natural gas pipeline. The aim of the planned activity is described in chapter 2 of this report and is not repeated in the Natura appropriate assessment chapter. **The planned activities are not directly linked to or necessary to achieve the conservation aims of Natura sites.**

The planned offshore pipeline from Ingå to Paldiski is a line object. The diameter of the planned natural gas pipeline is 20 in (508 mm) and the total length approx 81 km; the length can vary by 2 km depending on the alternative chosen. The lifespan of the pipeline is about 50 years. On decommissioning, the pipeline will be left on the seabed.

The pipeline will pass through two Natura sites in Estonian territorial sea – Pakri Habitats and Birds Directive sites. The Pakri Habitats and Birds Directive Sites completely overlap, forming a Natura site with a territory of 20,574.8 ha (*EELIS 2014*) approx 84% of which is the sea.

ALT EST 1 route of the pipeline would pass through the Pakri Habitat and Bird Area to an extent of approx 5.3 km, and ALT EST 2 route to the extent of approx 2.1 km. A possible ALT EST 1 landfall is located in Lahepere Bay, where the pipeline would be brought to mainland at Kersalu in the City of Paldiski, near the border of Keila Parish. The landfall of ALT EST 2 is located in the northeast part of Pakri Peninsula, at Pakrineeme. The landfall of ALT EST 1 and ALT EST 2 are located within the Pakri Habitats and Birds Directive Sites or near their border.

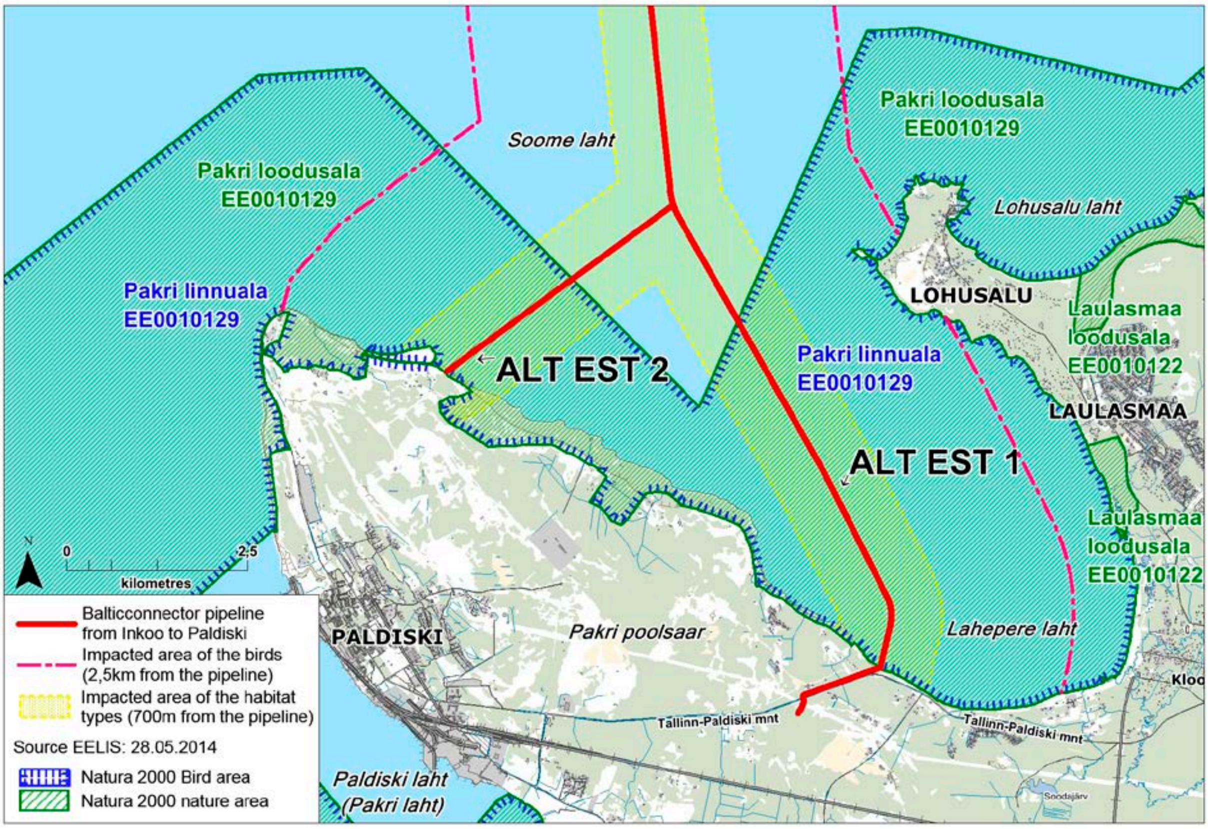


Figure 6-29. Planned natural gas pipeline and potentially impacted marine area within Pakri Habitats and Birds Directive Sites.

Installing the planned gas pipeline will take place using different methods within the Pakri Natura site. For both alternatives, it is planned to lay the gas pipeline in a trench, which will be covered by a layer of rocks even to the seabed extending 2 km toward the open sea, in order to protect the pipeline from ship traffic and ice. Near the coast to an extent of approx. 500 m, it is planned the layer of rocks will be 2 m thick, and approx 1 m above the pipeline in the trench in sections furtheron. In other sections within the Pakri Natura Site, the pipeline will be laid directly onto the seabed and covered with a layer of rocks approx. 1 m thick. The width of the rock layer is approximately 5 m to either side of the pipeline or a total of 10 m. The width of the project activity zone is estimated to be approx 25 m to either side of the axis of the pipeline.

Landfall construction of the gas pipeline at ALT EST 1 is planned by means of a trench, and that of ALT EST 2 through a constructed microtunnel. (*Ramboll 2014a*).

Project impact area and potential impacts

Impact area at sea:

- On coastal habitats – directly in a zone 50-m wide; depending on the dispersion of sediment (section 6.5.2), the impact can extend to about 600–700 m on either side of the gas pipeline.
- On birds – 2,500 m on either side of the gas pipeline. Size of the impact area is based on the extent of underwater noise.

Impact area on mainland:

- On mainland habitats – directly in a zone 50 m wide;
- On mainland species – directly in a zone 50 m wide; impact of construction noise can extend up to a kilometre on either side, depending on landscape type and wind direction.

Natura assessment analyzes the potential impacts in different project phases or during construction, commissioning, operation, and maintenance. According to the pre-FEED report (*Ramboll 2014a*), possible blasting can only take place at approx. 10 km from the boundary of the Natura site.

Table 6-32. Planned project activities and potential impact on the Natura site

	Project phase	Activities	Potential impact
Natura 2000 site	Offshore construction	Anchoring Leveling the seabed (Rock placement, dumping) Dredging Accumulation storage of sediment on the seabed Pipeline installation offshore pipelaying	- Re-suspension of sediment, releasing nutrients and dangerous substances - Noise - Physical destruction and/or damage to habitats
		During construction	- Visual and light pollution - Generation of waste
	Onshore construction	Moving soil Extraction Movement of heavy equipment Activity linked to landfalls (ALT EST 2 landfall through a microtunnel)	- Destruction and/or damage to habitat types - Destruction of and/or damage to growth locations and nesting locations of species - Destruction of and/or damage to hiding and feeding locations of species - Damage to migration routes of species - Changing the water regime - Noise - Possible temporary light pollution - Generation of waste
	Commissioning (precomissioning comissioning)	Hydrotesting Gauging and cleaning De-watering and drying Filling with gas	- Noise due to work - Extraction of polluted water
	Operational phase and maintenance	Gas flowing Maintenance transport Maintenance work (placement of rocks when necessary)	- Noise
		Existence of the rock layer	- Formation of a secondary habitat
		Routine maintenance, possible replacement of rocks	- Physical damage to the seabed

6.7.2 Description of potentially impacted Natura 2000 areas

6.7.2.1 Pakri Habitats Directive Site (EE0010129)

Based on Order no 615 issued by the Government of Estonia "List of Natura 2000 network areas to be submitted to the European Commission", the Pakri Habitats Directive Site is included in the Natura 2000 network for the protection of 5 species and their habitats as well as 22 habitat types. 8 of the protected habitat types are priority habitat types. Priority habitat types are marked with an asterisk.

Habitat types in Annex I to the Habitats Directive which are protected in the Pakri area, are as follows:

Coastal habitat types:

Sandbanks which are slightly covered by sea water all the time (1110), estuaries (1130), coastal lagoons (1150*), large shallow inlets and bays (1160), reefs (1170). The extention of potentially impacted habitats in the Pakri Habitats Directive Site is shown in Table 6-36.

Mainland habitat types:

Annual vegetation of drift lines (1210), perennial vegetation of stony banks (1220), vegetated sea cliffs open to the sea (1230), boreal islets and small islands (1620), boreal coastal meadows (1630*), grey dunes (fixed coastal dunes – 2130*), hard oligo-mesotrophic waters (3140), rivers and streams (3260), Juniperus communis formations on heaths or calcareous grasslands (5130), dry grasslands on calcareous substrates (*important orchid sites – 6210), alvars (6280*), wooded meadows (6530*), springs and springfens (7160), alkaline fens (7230), old broad-leaved forests (9020*), swamp woods (9080), and forests of slopes, screes and ravines (9180*).

Species listed in Annex II to the Habitats Directive whose habitats are protected, are as follows:

Flowering plants marsh angelica (*Angelica palustris*), sand pink (*Dianthus arenarius subsp. arenarius*), fen orchid (*Liparis loeselii*), tortella moss (*Tortella rigens*) and insect scarce fritillary (*Euphydryas maturna*).

The following habitat types and species included under the protection aims of Pakri Habitats Directive Site listed under the Natura 2000 network will be in the potential impact zone of the planned activities:

- Coastal habitats: 1110 (Sandbanks which are slightly covered by sea water at all times), 1170 (reefs);
- Mainland habitat types: 1230 (vegetated sea cliffs open to the sea), 6210* (dry grasslands on calcareous substrates), 6280* (alvars), 9180* (forests on banks);
- Species: scarce fritillary (*Euphydryas maturna*) potentially occuring at ALT EST 1.

Offshore, the ALT EST 1 route of the pipeline would go through habitat type 1110 (sandbanks) in Lahepere Bay to an extent of approx 4.3 km. On the mainland, there are no habitat types classified by the Habitats Directive within the impact area of the pipeline. The closest mainland habitat type to the landfall point of ALT EST 1 classified under the Habitats Directive is 6210 (*important orchid sites), which is located in Pakri Habitats Directive Site approx 500 m from the landfall point towards the northwest.

In the case of ALT EST 2, the onshore pipeline will pass through habitat type 1110 (sandbanks) to an extent of approx 1 km and 1170 (reefs) to an extent of approx 500 m. On the mainland, there are habitat types 1230 (sea cliffs open to the sea) and 9180* (bank forests) registered during the inventory of 2014 within a 50-m range of the landfall point. Earlier inventories have found habitat types 6210* (dry grasslands on calcareous substrates) and 6280* (alvars) within 55–60 m of the landfall of ALT EST 2 (*EELIS 2014*).

As regards Habitats Directive species, ALT EST 1 will cross the habitat of a scarce fritillary (*Euphydryas maturna*) about 120 m from the landfall point. However, this habitat is not located within the Pakri Habitats Directive Site, and therefore the impact is described in section 6.6.5.

Description of potentially impacted habitats

Habitat type 1110 – sandbanks which are slightly covered by sea water all the time (Paal, 2007). Based on the definition from 2007, this habitat type is a formation of various shapes consisting mainly of sediments, and differentiated from the seabed. In addition to sandy sediment, the bottom substrate can include coarse fraction up to gravel and rocks. If the sand sediment covers harder substrate as a thinner or thicker layer, such areas are still classified under sandbanks if biological conditions characteristic to sandbanks are present in the sediment (*TÜ Eesti Mereinstituut 2009*). The following species of phytobenthos are characteristic to sandbanks: common eelgrass (*Zostera marina*), widgeongrass (*Ruppia maritima*), fennel pondweed (*Stuckenia pectinata*), horned pondweed (*Zannichellia palustris*) and Charophyta. Dominat species in the benthic fauna are Baltic tellin, soft clam, and lagoon cockle. The benthic fauna functions as an important feeding, spawning, and hiding location for various fish. Benthic fauna on sandbanks is also a source of food for sea birds. Sandbanks with grater species richness are located within the spread of vegetation. Usually sandbanks do not extend deeper than 20 m, however, by definition the depth can be greater if the sediment contains elements characteristic to sandbanks. Therefore, according to the new definition there are two main factors: structure of the sediment (sand must dominate) and characteristic biological components. Generally the habitat type is not endangered in Estonian coastal waters. (*TÜ Eesti Mereinstituut 2009*).

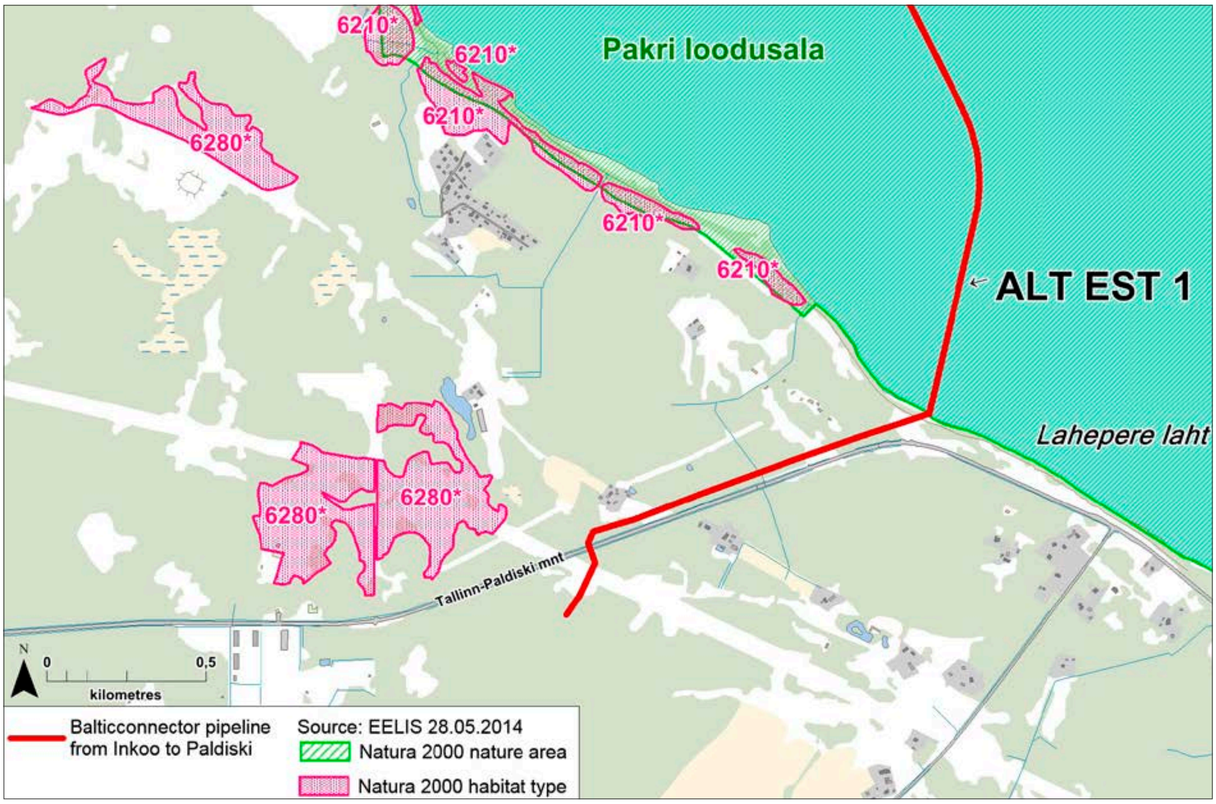


Figure 6-30. Mainland habitat types in the ALT EST 1 area. Note that the three westernmost alvar patches (6280*) are outside the Natura 2000 site.

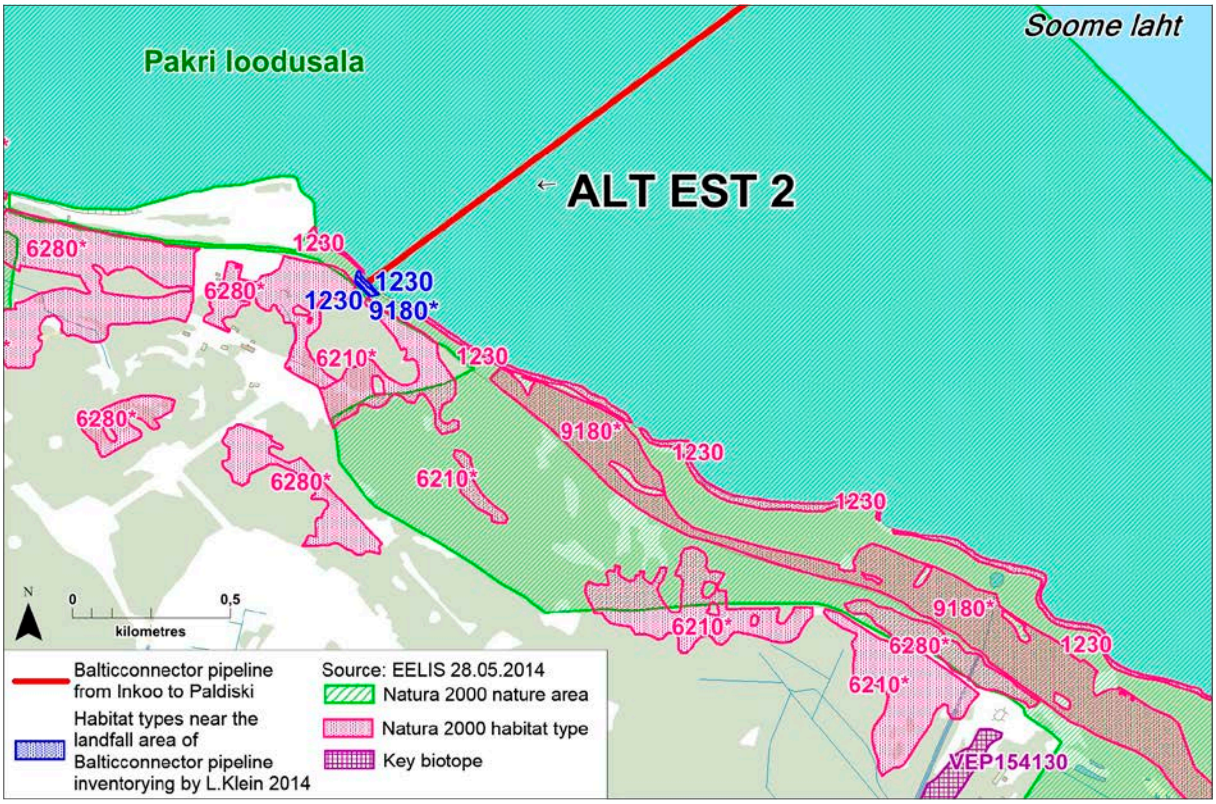


Figure 6-31. Mainland habitat types in the ALT EST 2 area.

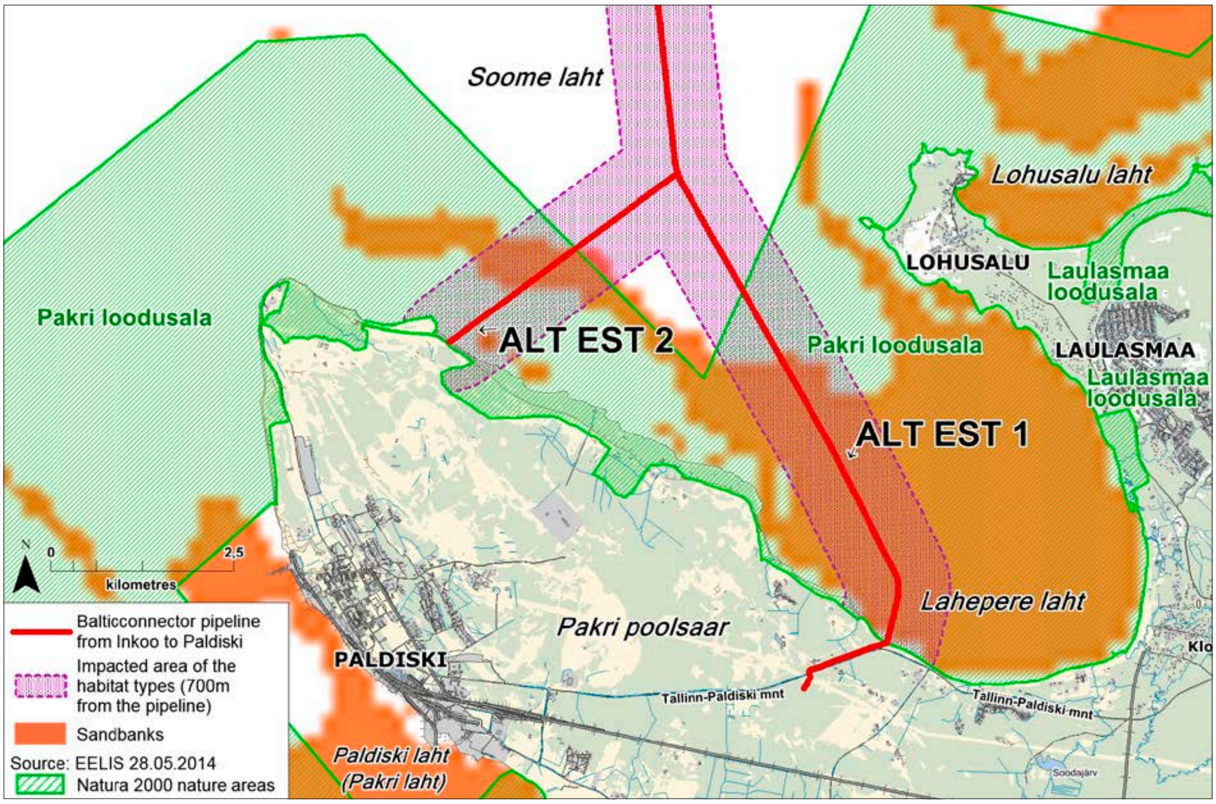


Figure 6-32. Sandbanks (1110) at project potential impact area within Pakri habitats directive site.

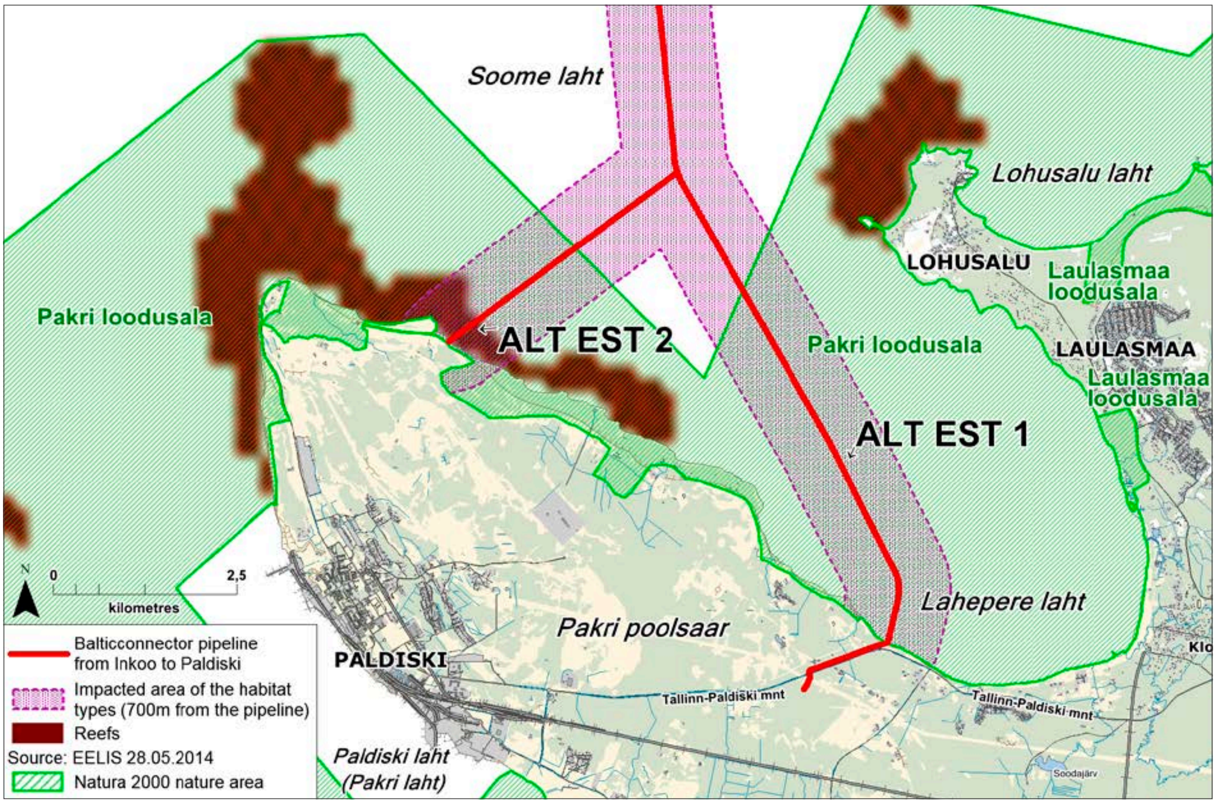


Figure 6-33. Reefs (1170) at the project potential impact area within the Pakri Habitats Directive Site.

Habitat type 1170 – reefs. In the context of the Habitats Directive (definition specified in 2007) reefs are hard formations arising from the seabed to the littoral or sublittoral zone. No specific depth parameter is applicable for this habitat; existence of the habitat is defined by zonation of biological characteristics. Characteristic species in the Baltic Sea include bladderwrack, agar-agar, bay mussel, zebra mussel, and common barnacles. Reef fauna is characterized by extremely high biological productivity and dynamic environmental conditions. In Estonia, the habitat type includes areas rich in boulders or higher rocky areas on the seabed, which can extend above water when the water level is low. This habitat is less common in Estonian waters when compared to sandbanks. It is mostly seen in areas of seabed slopes of morenic origin and underwater limestone outcrops. (*TÜ Eesti Mereinstituut 2009*) Lower parts of reefs are an important source of food for benthic species and Dabbling Ducks.

Habitat type 1230 – vegetated sea cliffs open to the sea characterized by a bank formed out of durable Palaeozoic rock, limestone, dolomite (*Paal 2007*).

Habitat type 9180* – bank forests. Mixed forests of secondary tree species growing on rubble and steep slopes, mainly consisting of carbonate minerals as well as silicates. Vegetation is supported by a relatively high humus content in the soil and corresponding high nutrients, good water support as well as soil texture (mainly loam) and almost neutral reaction (*Paal 2007*). Characteristic trees for this habitat include elm, ash, basswood, maple, and grey alder. Bushes are characterised by bird cherry, viburnum, blackcurrant and alpine currant, honeysuckle. Ground vegetation is rich in these forests because varied moist and soils enable the growth of plants with different ecologic needs. This is a habitat type of primary importance, and its protection is a special responsibility.

Habitat type 6210* – dry grasslands on calcareous substrates. In an Estonian context, this habitat type includes semi-natural grasslands on mineral soil without cultures. If the vegetation on the grasslands has formed as a result of long-term grazing and/or mowing, it is necessary to continue in the regular manner in order to maintain diversity and condition. Mineral soils are important habitats for orchids (*Paal 2007*). This is a habitat type of primary importance, and its protection is a special responsibility.

Habitat type 6280* – alvars. Alvars are found in Estonia on Ordovician or Silurian limestone areas. Alvars are mostly dry or very dry habitats. Vegetation on alvars is usually sparse and low, but rich in species. Plants tolerating dry conditions and minerals dominate here. This is a habitat type of primary importance.

6.7.2.2 Pakri Birds Directive Site (EE0010129)

Based on Order no 615 issued by the Government of Estonia "List of Natura 2000 network areas to be submitted to the European Commission", the Pakri Birds Directive Site is included in the Natura 2000 network for the protection of 18 bird species and their habitats.

Species listed in the birds directive, whose habitats are present in the Pakri bird area, are the following: Eurasian Wigeon (*Anas penelope*), Mallard (*Anas platyrhynchos*), Greater Scaup (*Aythya marila*), Eurasian Bittern (*Botaurus stellaris*), Common Goldeneye (*Bucephala clangula*), Black Guillemot (*Cepphus grylle*), Long-tailed Duck (*Clangula hyemalis*), Tundra Swan (*Cygnus columbianus bewickii*), Whooper Swan (*Cygnus cygnus*), Mute Swan (*Cygnus olor*), White-tailed Eagle (*Haliaeetus albicilla*), Common Gull (*Larus canus*), Velvet Scoter (*Melanitta fusca*), Goosander (*Mergus merganser*), Ruff (*Philomachus pugnax*), Great Crested Grebe (*Podiceps cristatus*), Common Eider (*Somateria mollissima*) and Redshank (*Tringa totanus*).

Due to its rich and diverse coastal habitats, Lahepere Bay is used as a wintering, breeding and stop-over location by a number of bird species listed in Annex I to the Birds Directive. During a survey conducted in 2014 (*Eesti Ornitoloogiaühing 2014*), all species whose habitats are protected at the Pakri Birds Directive site were registered here, with the exception of Eurasian bittern. The most numerous were long-tailed duck and common goldeneye, and other common species included mallard and goosander. Most of the bird species are seabirds which feed on the surface or dive after benthic fauna or fish. Mainland habitats on the shore are mostly used for nesting and taking cover.

Description of species

Eurasian Wigeon (Anas penelope)
A common species for transit migration, arrives in March-April and leaves in September-October, in July, male birds come to the Baltic Sea for moulting, and therefore autumn migration is much more numerous than spring migration. Not a very common nesting species, in Estonia approx 100–200 pairs (*Elts 2009*). A few overwinter in the area. The number of birds in transit migration is estimated to be in the tens of thousands, especially valued migratory routes include Matsalu and Haapsalu Bay, coastal waters of North-West Estonia, Small Strait, Käina Bay, Pärnu Bay (*Lõhmus 2001*) with up to 4,000 birds. Maximum survey result in the project area is 38 birds. Paldiski Bay is considered to be a potentially important nesting area. However, this species has not been registered as nesting in the immediate project area (*Estonian Ornithological Society 2013*).

Mallard (Anas platyrhynchos)
A numerous species in Estonia, where it can be seen all year, depending on the weather conditions in the winter. The number nesting in Estonia is estimated to be approx 30,000 – 50,000 pairs (*Elts 2009*); the population during winter is approx 10,000 – 20,000

birds (*Elts 2009*) and up to tens of thousands of birds migrate through Estonia. In 2013–2014, the Mallard was also one of the most numerous species in the project area – maximum survey result was 267 birds (*Estonian Ornithological Society 2013*). The Mallard prefers nesting locations rich in vegetation protected from waves. This habitat type is not very common in the project area. However, based on the survey results, it is possible that the Mallard can nest in the area to a limited extent.

Greater Scaup (Aythya marila)
A rare nesting species in Estonia (1–10 pairs), but a numerous migratory and overwintering species. The population of breeding birds has decreased significantly: 150 pairs in the 1960s, up to 10 pairs in 2000s (*Elts 2009*). Tens of thousands of species can be seen in transit migration, approx 100–2,000 birds overwintering (*Elts 2009*). A maximum of 1,414 birds were counted at Lahepere Bay in 2013–2014; the preferred stopping location was in the western part of the bay at medium depth, i.e. in the vicinity of the project area. The population exceeded the criterion for area of local importance (*Estonian Ornithological Society 2013*). The most important migratory stopping location was Põõsaspea Cape, but the Pakri Birds Directive Site is also considered an important stopping location. Listed under Estonian Nature protection Category II.

Eurasian Bittern (Botaurus stellaris)
Arrives in Estonia in the first half of April, and starts to leave from the end of September, a major part of migration takes place in October. A few birds may overwinter in the area. Approximately 300–500 pairs nest in Estonia. Prefers sheltered coastal areas covered with canebrake, which are not very common in the project area. Therefore, this species probably does not nest in the area of ALT EST 1 or ALT EST 2. Listed under Estonian nature protection category II, as well as in Annex I to the Birds Directive.

Common Goldeneye (Bucephala clangula)
Is present in Estonia all year, depending on the weather conditions in the winter. Estimated number of overwintering birds is approx. 15,000–30,000, less common in nesting, approx 3,000–5,000 pairs.

A maximum of 2, 808 birds were counted in the project area (in November 2013), was one of the most numerous dabbling ducks in the area; the most numerous during autumn from September to October (*Estonian Ornithological Society 2013*). Population exceeded the criterion for area of local importance (*Estonian Ornithological Society 2013*). In Lahepere Bay, prefers to stop in the eastern part of the bay at medium depth, which is further away from the project area. Not known to nest in the vicinity of the project area.

Black Guillemot (Cepphus grylle)
This species is generally present in Estonia from May to October, but it can overwinter depending on ice conditions. The population during winter season is approx 1,000- 3,000 birds, the number of nesting pairs can be around 20–40 (*Elts 2009*). This is an Arctic species with very limited suitable habitats in Estonia, and therefore Pakri Cape (Pakri Neem) is the only known nesting location for this species. At Pakri, the species nests at the tip of the cape where the sea reaches the klint, and there are no trees growing between the klint and the sea. Nesting is known since at least 1870. In the 20th century the population size was described as follows (*Leibak 1994*):
1936 – ca. 100 pairs;
1960 – ca. 25 pairs;
1971 – ca. 20 pairs;
1983 – 6 pairs;
1986 and 1987 – 10 pairs.

In 2003–2008, 20–40 pairs are estimated to nest in Estonia (*Elts 2009*). However, the number of nesting birds can vary significantly. According to a survey conducted in 2005, 2010 and 2011 by Veljo Volke, Tiit Randla and Monika-Laurits Arro, the number of nesting pairs varied from 0 pairs (in 2011) to 15 pairs (in 2010). Nesting of Black Guillemots can depend on many aspects, both natural (harsh winter) as well as anthropogenic (disturbance).

Based on this survey, it was concluded that Black Guillemots can be present in the vicinity of project area ALT EST 2 when searching for food. Presumably the birds will feed as close as possible to the nesting location in order to save energy, but they can be present in the project area when looking for food.

The population of Black Guillemots at Lahepere Bay during the winter was estimated to be small – around 10 birds (*Estonian Ornithological Society 2013*. Black Guillemot is listed under Estonian nature protection category II.

Long-tailed Duck (Clangula hyemalis)
Long-tailed ducks are numerous migratory and overwintering birds in Estonia. They do not nest here. It is a species which can overwinter in Estonia, with up to 500,000 birds depending on weather conditions, and therefore Estonian coastal waters, including the Pakri Birds Directive Site, are very important for the Long-tailed Duck as a migratory stop.

The common criterion for international importance for stopping water birds is the presence of at least 1% of the migratory population in the area. For the Long-tailed Duck, the new 1% criterion is 16,000 birds, which is significantly exceeded by the maximum survey result at Lahepere Bay – 17,700 birds. According to surveys, Long-tailed Ducks tend to gather in the western part of

Lahepere Bay, in the vicinity of the planned gas pipeline, and on the route of ALT EST 1 as well as ALT EST 2.

During past 20 years, the populations of this species are noted to decrease in the Baltic Sea area (*Skov 2011*), and therefore its important feeding and stopping locations need additional attention in Estonia.

Whooper Swan (Cygnus cygnus)
A common migratory species and less common nesting as well as overwintering species in Estonia. It is mostly seen during spring and autumn migration. Estimated population during winter months is approx 100 – 2,000 birds, around 10,000 – 15,000 birds stop during spring migration, nesting in the summer can include 70 –100 pairs. The largest groups are present at Matsalu and Haapsalu bay, the Pakri Birds Directive Site is noted as a very suitable migration stopping location. This is also confirmed by the maximum survey result of 41 birds in the project area (*Estonian Ornithological Society 2014*). The species is not known to nest in the project area. Whooper Swan is listed under Estonian nature protection category II, as well as in Annex I to the Birds Directive.

Mute Swan (Cygnus olor)
A rather numerous species in Estonia, where it can be seen all year, depending on weather conditions in the winter. Estimated population during migration and winter season is 5,000–15,000 birds, up to 3,500 nest in Estonia. The most significant overwintering and stopping locations are in the western part of Estonia. However, a rather large population overwinters at Lahepere Bay – the survey results have been high in October and January. Maximum survey results at the coastal areas of Lahepere Bay has been 135 birds (*Estonian Ornithological Society 2013*). No nesting has been registered in the project area, but it is known to nest on Pakri Peninsula.

Tundra Swan (Cygnus columbianus)
The Tundra Swan is a common migratory bird in Estonia during spring and autumn. Population during spring migration is around 60,000 birds, the number has been noted to decrease. Not known to nest in Estonia, a few birds overwinter (*Elts 2009*). Pakri Birds Directive Site is a significant stopping location during migration, but coastal areas in the western part of Estonia are more significant. Maximum survey result at Lahepere Bay was 22 birds. Listed under the Estonian nature protection category II, as well as in Annex I to the Birds Directive.

White-tailed Eagle (Haliaeetus albicilla)
A rare species in Estonia. Non-migratory bird which can be seen all year. Population in Estonia during winter season is estimated to be around 600–900 birds, number of hatching pairs approx 150–170 (*Elts 2009*). The population has been increasing. White-tailed Eagle can be present in the project area with a few birds when looking for food. In the survey period of 2013–2014, the White-tailed Eagle was seen in the project area five times (*Estonian Ornithological Society 2014*). White-tailed Eagle is listed under Estonian nature protection category I, as well as in Annex I to the Birds Directive.

Common Gull (Larus canus)
A common and numerous coastal bird. The number of pairs nesting in Estonia is approx 10,000–15,000 pairs, around 1,000–10,000 birds remain during the winter season.

Is presumed to nest at Lahepere Bay in the project area, and is one of the most common birds all year. During the nesting survey of 2014, 6 nesting pairs were counted on the coastal rocks in the vicinity of alternative 1. Maximum survey result during coastal survey was 97 birds. This is a pelagic species that can move quite far from the coast when looking for food.

Velvet Scoter (Melanitta fusca)
A numerous migratory and nesting species seen all year. Estimated population in Estonia during the winter season can extend up to 200,000 birds, number of nesting pairs approx 400–700. The number of migratory birds has been estimated at around 1 million earlier (*Leibak 1994*).

Lahepere Bay is a probable significant nesting location for this species, because during the surveys of 2013–2014 it was seen rather frequently. The Velvet Scoter is the most numerous at Lahepere Bay from February to April, the highest survey result was in early spring of 2014 – 338 birds (*Estonian Ornithological Society 2013*). Probably does not nest in the project area. Listed under Estonian nature protection category III, and classified as globally *vulnerable* by the International Union for Conservation of Nature IUCN.

Goosander (Mergus merganser)
A common migratory, nesting and overwintering bird in Estonia. Population during nesting is estimated around 1,500–2,000 pairs, whereas around 4,000–8,000 birds can be present in Estonia during the winter season. Two hatching pairs were spotted near ALT EST 1 in the project area during the nesting period survey in 2014. There is no information on nesting in the area of ALT EST 2. During the non-nesting period, this species was often spotted during 2013–2014 survey at Lahepere Bay – maximum result of coastal survey was 63 birds (*Estonian Ornithological Society 2014*).

Ruff (Philomachus pugnax)
A common migratory, but rare nesting bird. Hatching pairs around 20–50 (*Elts 2009*). At Lahepere Bay, the maximum coastal survey result was 16 birds (*Estonian Ornithological Society 2013*). Four nesting pairs were registered in 2001 at Pakri Bay. Ruff was not registered

as nesting in the area of alt 1 during nesting period survey of the Ornithological Society in 2014, and it is also unlikely in the area of ALT EST 2 because their preferred nesting locations, damp grasslands, are almost non-existent. Ruff is listed under Estonian nature protection category I, as well as in Annex I to the Birds Directive.

Great Crested Grebe (Podiceps cristatus)
A common nesting and migratory bird in Estonia. Number of hatching pairs is around 2,000–3,000, population during winter season approximately 30–300 birds. The trend is increasing. The population at Lahepere Bay exceeded the criterion for an area of local importance; the highest number of Great Crested Grebes was present in the project area in the second half of October (*Estonian Ornithological Society 2013*). The maximum result of coastal survey was 197 birds (*Estonian Ornithological Society 2013*). No nesting in the project area was registered during the summer survey of 2014, although approximately 10–30 pairs nest at nearby Pakri Bay (*OÜ E-Konsult 2011*).

Common Eider (Somateria mollissima)
A common migratory bird (10,000–20,000 birds) in Estonia, which can be seen during nesting (3,000–7,000 pairs) as well as winter periods (20–100 birds). At Lahepere Bay, the Common Eider is the most numerous during the first half of May. Maximum survey result in 2014 was 130 birds. At Lahepere Bay, it mainly gathers in the open part of the bay, northeast of Pakri cape (Pakri neem). Common Eider was not registered during the nesting period survey in alt 1 area, but this species can still nest in ALT EST 2 area.

Redshank (Tringa tetanus)
A common coastal bird, which can be seen nesting as well as migrating through Estonia, the population is decreasing. The number of nesting pairs is around 5,000–7,000 (*Elts 2009*). Areas suitable for nesting include damp coastal meadows with high vegetation, which are not present in the project area. Therefore, the species is not likely to nest in the area of ALT EST 1 or ALT EST 2. Only a limited number of birds were seen in the project area during the survey of 2013–2014. Listed under Estonian nature protecttion category III.

Table 6–33. Presence of species protected under the Natura 2000 birds site in the project area during nesting period.

Species	Species nesting in the canebrake	Nesting species linked to the shoreline	Presence of suitable nesting location for the species at the planning area or in its vicinity	Alternative in the vicinity of the nesting location	Nature conservation category
Eurasian Wigeon			–		–
Mallard	+	+	–	–	–
Greater Scaup			–		(NC II)
Eurasian Bittern	+		–		(NC II)
Common Goldeneye			–		–
Black Guillemot		+	+	ALT EST 2	NC II
Long-tailed Duck			–		–
Tundra Swan			–		(NC II)
Whooper Swan			–		(NC II)
Mute Swan	+	+	+	ALT EST 2	–
White-tailed Eagle			–		(NC I)
Common Gull	+	+	+	ALT EST 1 AND ALT EST 2	–
Velvet Scoter		+	–		NC III
Goosander		+	+	ALT EST 1 AND ALT EST 2	–
Ruff		+	+	ALT EST 2	NC I
Great Crested Grebe	+		–		–
Common Eider		+	+	ALT EST 2	–
Redshank		+	–		NC III

Based on existing information, it is possible that the following birds nest in the project area (in the vicinity of ALT EST 1 as well ALT EST 2): Mallard, Common Goldeneye, Black Guillemot, Mute Swan, Common Gull, Velvet Scoter, Goosander, Ruff, Great Crested Grebe, Common Eider, and Redshank.

Table 6-34. Presence of species protected under the Natura 2000 birds site in the project area outside nesting period.

Species	Migration stop (spring + autumn)	Overwintering
Eurasian Wigeon	+	
Mallard	+	+
Greater Scaup	+	+
Black Guillemot	+	+
Common Goldeneye	+	+
Long-tailed Duck	+	+
Tundra Swan	+	
Whooper Swan	+	
Mute Swan	+	+
White-tailed Eagle	+	+
Common Gull	+	+
Velvet Scoter	+	+
Goosander	+	
Great Crested Grebe	+	+
Common Eider	+	
Redshank	+	

Based on existing data, the project area is an important stopping and overwintering location for the following species: Eurasian Wigeon, Mallard, Greater Scaup, Common Goldeneye, Long-tailed Duck, Tundra Swan, Whooper Swan, Mute Swan, White-tailed Eagle, Common Gull, Velvet Scoter, Goosander, Great Crested Grebe, Common Eider, and Redshank.

6.7.3 Assessment of impact

6.7.3.1 Assessment of impact on Pakri habitats

Impact on coastal habitats

Impact during construction

Planned construction activity will cause direct physical damage to habitats in the range of 25 m to either side of the pipeline or within the project area, which is linked to excavating the trench, repositioning the sediment, storage as well as other construction work.

In the case of ALT EST 1, a layer of rock will be generated, and the natural seabed consisting of sand and gravel will be substituted by a rocky seabed over a total width of approx 10 me, which will permanently destroy habitat 1110 (sandbanks) of a total area of approximately 4.3 ha. Natural habitat type 1110 will not be restored on the areas covered by rocks. Potential impact in this case can be more extensive than only the area covered by rocks, because a rocky barrier will split the habitat type into two parts as an uninterrupted line along the whole habitat area, thus interrupting movement of benthic species and damaging the coherence between parts of habitat. There is not negative impact on the coherence of the Natura site.

ALT EST 2 would physically damage two natural habitat types in the sea - 1170 (reefs) and 1110 (sandbanks). Habitat type 1170 (reefs) is characterized by a rocky bottom, and therefore if a layer of rock is constructed the characteristic communities of the habitat can be restored. However, if artificial substrate are used for backfilling of dredge, the natural habitat will be destroyed permanently, and the impact would be also permanent. Natural habitat will be permanently destroyed over a very small area. Total damage to the natural habitat is estimated to be 0.04% of whole habitat in the Pakri Natura Site (see Table 6-35). There is no negative impact on the coherence of Natura site. **The negative impact on whole habitat within the Pakri Natura Site is low. The impact is assessed as not significant for whole habitat.** Natural material excavated from a trench in the same area has to be used for filling in that case. Habitat type 1110 would be permanently destroyed over an area of approximately 1 ha, which is significantly less when compared to the first alternative. However, artificial substrate would still be generated, and habitat type 1110 would be divided into sections.

Depositing the sediments removed by dredging will bury the habitat under the sediment, thereby destroying the key communities. After construction work has been completed, the benthic fauna in the area is expected to recover. The impact is spatially limited, and takes place within the construction area, approx. to an extent of 25 m from pipeline axis.

The protective measure planned for the protection of the pipeline (i.e. using rocks for filling the trench and for covering the pipeline on the seabed) will cause permanent damage to habitat type 1110 in both alternatives. The area of the habitat type may decrease irreversibly, and the habitat will be divided into separate sections. On the other hand, in time habitat 1110 will be damaged over a very small area compared to the whole area of sandbanks within the Pakri Habitats Directive Site. However **potential significant impact** on the habitat **cannot be excluded**, as the artificial barrier will divide habitat 1110 into sections (see Figure 6-32). **Potential significant impact is possible to avoid using the mitigation methods described in the chapter 9** Mitigation measures**.** Mitigation measures will help flora to recover in time, which leaves the general impact for the habitat insignificant.

Table 6-35. Spatial damage to natural sea habitat types due to planned activities at the Pakri Habitat Directive site without mitigation measures.

Type	Total habitat area at Pakri [ha]	ALT EST 1			ALT EST 2		
		Permanent loss [ha]	Temporary loss [ha]	Total damage %	Permanent loss [ha]	Temporary loss [ha]	Total damage %
1110	15000	4.3	17.2	0.14	1	4	0.03
1170	7000	-	-	-	0,5	2	0.04

An indirect negative impact on the condition of the habitats can be caused by the suspended particulate matter generated during construction work. Suspended matter reduces transparency in the water column and also can settle on key fauna species of the habitat, thereby inhibiting the photosynthesis and growth of seaweeds. According to modeling results (see section 6.5.2), most of the suspended matter in Lahepere Bay will settle within 5 days in direct vicinity to the pipeline in the range of approx 600–700 m at a concentration of > 10 g/m². Fine suspended matter can remain in the water for longer periods and spread to a wider area. However, its concentration in the water would be very low. In the case of ALT EST 1, the suspended matter will settle within Lahepere Bay and cause a greater impact than ALT EST 2, where re-suspended particles will settle in the mouth of Lahepere Bay. The potential impact on habitats due to resuspended particles is temporary. **The impact can be considered as moderate on Natura habitats.** To reduce the negative impact, the monitoring of the dispersion of suspended matter must be carried out during construction work at sea.

Moving the bottom sediment during construction work will release harmful substances and nutrients from the sediment into the water column. In high concentrations, this can have a negative impact on the key species of habitats and thereby on the condition of habitats. A chemical analysis in the upper layer of sediment conducted in 2013 indicated a low content of harmful substances and organic matter in the sediment of Lahepere Bay (*TTÜ Meresüsteemide Intituut 2013*), and therefore it can be concluded that the impact would be **minor.**

Commissioning

The pipeline will be tested and cleaned before operating. During this phase it will be filled with seawater containing biosulfite ($NaHSO_3$) and/or biocide. According to present information, the water will be discharged into the sea after testing. However, the area of this activity is not known. As there are no studies on how this could impact the condition of the habitats, it is not allowed to release polluted water into Lahepere Bay and its vicinity.

Operation and maintenance

There is a possibility that anodes will be released from the protective layer of the pipeline during operation. No extensive studies on this topic exist in the world, but according to the EIA report approved by Nord Stream, these concentrations will be very low and **will not have a significant impact.**

According to the project, the pipeline will be covered by a layer of rocks, which means that the seabed type will be replaced, or "artificial reefs" will be formed on a soft seabed. Natural habitat (1110) will not be restored in areas covered by these rocks, and species characteristic to habitat 1170 will appear on the artificial reefs. Methods for protecting the pipeline will cause an irreversible impact, but this is restricted to a very small area. The significance of this impact has been addressed earlier in the section *Impact during construction*.

Habitats can be physically damaged during maintenance if rocks are dumped or sediment is moved. This maintenance is of a local nature, and its spatial extent and duration is limited. It can be thus be concluded that such work **will not have any significant negative impact on the habitats.**

Impact on habitats and species on the mainland

Impact during construction

Similarly to the impact on coastal habitat types, the planned construction work will also directly physically destroy mainland habitats. More destruction and damage will be limited to habitats in the range of 25 m to either side of the pipeline or within the project area, which is linked to excavating the trench, repositioning the sediment, storage, as well as other construction work.

There are no habitat types listed in Annex I to the Habitats Directive in the impact area of ALT EST 1 (Figure 5-53). This alternative **does not include the impact** on habitat types listed as protected in the Pakri Habitats Directive site. With regard to feeding and hiding locations, the most sensitive species for the mainland route of ALT EST 2 includes ephemera that are adapted to mosaic meadows. Such species include the scarce fritillary listed as being under protection in the area. As the necessary habitats of the scarce fritillary are not located within the Pakri Habitats Directive Area, the impact of the planned activities on this species is described in section 6.6.5. Construction work at the landfall ALT EST 2 does not pose any risk to the butterflies.

The impact of construction activity at the landfall ALT EST 2 is expressed in changes to habitats, as well as in disturbance during construction. Habitat types 1230 and 9180* are located in the direct impact area of the landfall. Habitat types 6210* and 6280* are located in the indirect impact area. The pipeline will be brought to the mainland using a microtunnel, which causes less damage to habitat types, and a smaller impact, since the pipeline is brought to the mainland without coming into contact with local fauna.

Habitat type 9180* is located in the direct impact zone of ALT EST 2. This is a priority habitat type, which is characterized by mixed forests of secondary tree species growing on rubble and steep slopes, mainly consisting of carbonate minerals, as well as silicates (*Paal 2007*) or bank forests. Taking into account the fact that the landfall ALT EST 2 is planned to be constructed through a microtunnel, and this method should not have any significant impact on the surface, the impact of construction activity on habitats is predicted to be low and limited to impact due to vibration and disturbances in the water regime. At the same time, the sandstone bank on the shore and the limestone bank slightly further, away as well as the bank forest rich in micro-terrain, are very sensitive to vibration. The scarps can start to fracture as a result of micro fractures, or they can be more sensitive to weather conditions when compared to surrounding sections not affected by the activity. The incorrupt and developed micro-terrain functions as a habitat and substrate for a number of invertebrates as well as for moss and lichen. Even the smallest changes in this micro-terrain can have an irreversible negative impact on them. All this changes the conditions of these habitats and impacts the value for nature conservation in a negative direction. There is also a risk that logging will take place during construction work, and that soil will be damaged by excavation or in some other way (movement of construction equipment), which would cause damage and decline in local conditions. The impact is generally irreversible if it is not allowed to grow forest onto the gas pipeline route (microtunnel). Decrease in the area and decline in the condition of habitat type 9180* must be regarded **a significant negative impact.**

Habitat type 1230 of the Habitats Directive is also located in the direct impact area of construction work. If the pipeline is brought to mainland through a microtunnel, the soil will not be significantly damaged. If the movement of construction equipment is organized in a manner minimizing damage to the soil, then the negative impact on this habitat type is **regarded as insignificant.** This habitat is not classified as a priority habitat.

Primary habitat types 6210* and 6280* are also located in the indirect impact area of ALT EST 2 construction work. When the construction work is planned, it should be kept in mind that damage to these habitats is not permitted, and movement of people and equipment, waste storage and other activities during construction as well as maintenance work must be organized outside these habitat types. If these habitat types remain untouched and there is no decline in their condition, then **there is no impact on these habitats.**

Construction and other activities must be planned so as to not damage habitat types of primary importance, nor cause deterioration to their condition.

Operation and maintenance

Although the impact of operating and maintenance is limited to keeping the route open and maintaining necessary access roads, **the impact may be high to the habitat 9180 ***.

Table 6-36. The potential impact on the Pakri Habitats Directive site and mitigation measures.

Natura value	ALT EST 1			ALT EST 2		
	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures
1110	*Direct impact includes permanent loss of the natural habitat in the extent approx. 4.3 ha due to rock filling and temporary loss in the extent approx. 17.2 ha due to depositing of dredged sediment and other construction activities. Total damage of habitat is estimated 0.14% of whole habitat in the Pakri Natura 2000 Site. The natural habitat will be permanently destroyed over a very small area. The impact is not significant for the habitat as a whole.	*Dredged sediment must be stored for a very short period and kept outside Pakri Habitats Directive Site based on natural conditions in order to use it later for backfilling the trench. *The same material excavated during dredging must be used for backfilling the trench in the extent of habitat type 1110.	*Mitigation measures help avoid permanent damage to valuable habitat, and enable the better restoration of habitats after construction works. *The restoration of habitat on damaged area will take place during 1-5 years after construction. The impact should be considered as insignificant.	Direct impact includes permanent loss of the natural habitat in the extent approx.1 ha due to rock filling and temporary loss in the extent approx. 4 ha due to depositing of dredged sediment and other construction activities. Total damage of habitat is estimated 0.03% of whole habitat within the Pakri Natura Site. The habitat will be permanently destroyed on very small area. The impact is moderate. The impact assessed as not significant for the habitat as a whole.	*Dredged sediment must be stored for a very short period and kept outside Pakri Habitats Directive Site based on natural conditions in order to use it later for backfilling the trench. *The same material excavated during dredging must be used for backfilling the trench in the extent of habitat type 1110.	*Mitigation measures help avoid permanent damage to natural habitat, and enable the better restoration of habitat after construction works. *The restoration of habitat on damaged area will take place during 1-5 years after construction. The impact should be considered as insignificant.
	*Indirect impact can occur due to rock barrier along Lahepere Bay that would split habitat into two parts in the extension 4.3 km within the Natura site. Impact of the rock barrier on the coherence of natural habitat is difficult to predict. The potentially high negative impact on habitat cannot be excluded due to splitting the habitat with rock barrier.	*The same material excavated during dredging must be used for backfilling the trench in the extent of habitat type 1110 to avoid splitting and permanent damage to valuable habitat, and enable the restoration of habitats after construction works. *The monitoring of habitat should be performed every year after construction works at least within 5 years until acceptable recovery level of habitats.	*There is not splitting of habitat and restoration of habitat will take place during 1-5 years after construction. The impact is low/moderate. The impact is insignificant.	*Indirect impact can occur due to rock barrier that split habitat 1110 within the Natura site into two parts in the extension approx. 1 km. Impact of the rock barrier on the coherence of natural habitat is difficult to predict. The impact is moderate. The impact assessed as not significant for whole habitat.	*The same material excavated during dredging must be used for backfilling the trench in the extent of habitat type 1110 to avoid splitting and permanent damage to valuable habitat, and enable the restoration of habitats after construction works. *The monitoring of habitat should be performed every year after construction works at least for minimum of five years until acceptable recovery level of habitats.	*There is not splitting of habitat and restoration of habitat will take place during 1-5 years after construction. The impact is insignificant.

Natura value	ALT EST 1			ALT EST 2		
	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures
	*Indirect temporary negative impact can occur due to suspended matter generated during construction in the radius approx. 600–700 m from working area. Suspended matter spreads and settles within Lahepere Bay. Suspended matter in the water column causes reduction in water transparency and settling on key fauna species of habitat that can temporary inhibit photosynthesis and growth of seaweeds. The spatial extension of working area is about 4.3 km along Lahepere Bay. The impact is moderate.	*During construction work must be performed a monitoring of dispersing of suspended matter, to prevent this dispersing in concentration > 10 g/m2 over an extensive area.	*Mitigation measure will help avoid spreading of suspended matter over extensive area and thereby to reduce spatial extension of impact. *Avoiding of dredging during certain period helps reduce impact on the growth of phytobenthic communities of habitat. *The impact is not possible to avoid completely.	*Indirect temporary negative impact can occur due to suspended matter generated during construction in the radius approx. 600–700 m from working area. The highest amount of suspended matter forms and spreads in the mouth of Lahepere Bay, partly outside of Natura site. Suspended matter in the water column causes reduction in water transparency and settling on key fauna species of habitat that can temporary inhibit photosynthesis and growth of seaweeds. The spatial extension of impact on this habitat is about 1 km along. The impact is insignificant.	*During construction work must be performed a monitoring of dispersion of suspended matter, to prevent this dispersing in concentration > 10 g/m2 over an extensive area.	*Mitigation measure will help avoid spreading of suspended matter over extensive area and thereby to reduce spatial extension of impact. *Avoiding of dredging during certain period helps reduce impact on the growth of phytobenthic communities of habitat.
	*Moving of bottom sediment during construction work will release harmful substances from the sediment into the water. In high concentrations this can have a negative impact on the condition of habitats. A chemical analysis in the upper 20 cm layer of sediment conducted in 2013 indicated a very low content of pollutants and organic matter in the sediment of Lahepere Bay (TTÜ Mereuuringute Instituut 2013), and therefore it can be concluded that the impact would be minor.	It is not allowed to use polluted sediment with high organic content for backfilling the trench.	No impact	Moving of bottom sediment during construction work will release harmful substances from the sediment into the water. In high concentrations this can have a negative impact on the condition of habitats. A chemical analysis in the upper 20 cm layer of sediment conducted in 2013 indicated a very low content of pollutants and organic matter in the sediment of Lahepere Bay (TTÜ Mereuuringute Instituut 2013), and therefore it can be concluded that this would not have significant negative impact.	There is not allowed to use polluted sediment with high organic content for backfilling the trench.	No impact

Natura value	ALT EST 1			ALT EST 2		
	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures
1170	No impact	-	-	*Direct impact includes permanent loss of the natural habitat due to artificial rock filling to an extent ofapprox.0.5 ha due to artificial rock filling and temporary loss in the extent approx. two ha due to depositing of dredged sediment and other construction activities. Total damage of natural habitat is estimated 0.04% of whole habitat in the Pakri Natura site. The natural habitat will be permanently destroyed over a very small area. There is not negative impact on the coherence of Natura site. The negative impact on whole habitat within Pakri Natura site is low. The impact assessed as not significant for whole habitat.	*Dredged sediment must be stored for a very short period and kept outside Pakri habitats directive area based on natural conditions in order to use it later for backfilling the trench. *The same material excavated during the dredging from habitat must be used for backfilling the trench in the extent of habitat type 1170. *The backfilled material must have characteristics of habitat 1170. *The monitoring of habitat must be performed every year after construction works at least for minimum of five years until acceptable recovery level of habitats.	*Mitigation measures help avoid permanent damage to natural habitat, and enable the better restoration of habitat after construction works. *The restoration of habitat on damaged area will take place during 1-5 years after construction. The impact is temporary and takes place on very limited area. The impact should be considered as insignificant.

Natura value	ALT EST 1			ALT EST 2		
	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures
				*Indirect temporary negative impact can occur due to suspended matter generated during construction in the radius approx. 600-700 m from work area. The highest amount of suspended matter forms and spreads in the mouth of Lahepere Bay, partly outside the Natura site. Suspended matter in the water column causes a reduction in water transparency and settling on key fauna species of habitat that can temporary inhibit photosynthesis and growth of seaweeds. The impact is insignificant.	*During construction work must be performed a monitoring of spreading of suspended matter, to prevent this spreading in concentration > 10 g/m2 over extensive area. *Avoid construction works in the sea during the period of intensive growth of benthic fauna, Aprill – August.	*Mitigation measure will help avoid spreading of suspended matter over extensive area and thereby reduce spatial extension of impact. *Avoiding of dredging during certain period helps reduce negative impact on the growth of phytobenthic communities of habitat.
				The possible negative impact on quality of habitat due to release of harmful substances from sediments. The impact is minor. The impact is minor.	It is not allowed to use polluted sediment with high organic content for back-filling the trench.	No impact
1230	No impact	-	-	*The negative impact is possible during construction of microtunnel, if the tunnel head takes place within the habitat, it can cause damage and permanent loss of habitat. The spatial extent of damaging is difficult to predict because exact coordinates of the microtunnel head are not known. This habitat is not classified as a primary habitat. No significant impact on this habitat is expected.	*The head of microtunnel (jacking shaft and exit) must be organized outside the habitat.	No impact

Natura value	ALT EST 1			ALT EST 2		
	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures
	No impact	-	-	*The movement of construction equipment within habitat can cause damage to the habitat.	*The movement of construction equipment must be organized in a manner to avoid damage to the soil within the habitat.	No impact
	No impact	-	-	Negative impact if the route of natural gas pipeline microtunnel must be marked on land. If it must be done then trees would be cut along the route and as an impact the habitat will be permanently lost.	If the marking of the route is compulsory and given activity is not possible to avoid, then the impact to the habitat can be described as moderate.	
9180*	No impact	-	-	*The habitat is a priority habitat. Possible negative impact can take place due to vibration during construction work that may cause the formation of micro fractures, thereby to increase the vulnerability of habitat to weather conditions. The negative impact on a priority habitat should be considered as high.	*The negative impact on habitat 9180* must be avoided. It is not possible to do any construction work that negatively affects the habitat.	
				Possible logging during construction work and damaging of soil by digging or in another manner (movement of construction equipment), which would cause damage and decline in local conditions. The impact is generally irreversible, as it is not allowed to grow forest above the gas pipeline. Decrease in the area and decline in the condition of habitat type 9180 must be considered a high negative impact. It is difficult to predict the area of possible damage at the moment.	*The impact on habitat 9180* must be avoided and the damaging of habitat is not allowed. *Logging, excavation, the movement of people and equipment, waste storage and other activities during construction as well as maintenance work must be organized outside this habitat type.	No impact

Natura value	ALT EST 1			ALT EST 2		
	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures	Impact without mitigation measures	Mitigation measures	Changes after mitigation measures
9180*				Negative impact if the route of natural gas pipeline microtunnel must be marked on land. If it must be done and trees cut along the route, that will cause permanent loss of habitat, then the activity has high negative impact on the habitat.	If the marking of the route is compulsory and given activity is not possible to avoid, then it is an alternative where significant impact is not possible to avoid.	
6210*	No impact	-	-	*The habitat is located outside the direct impact area. The possible movement of equipment during construction work within the habitat can damage the habitat. The spatial extent of possible damage is not possible to determine due to lack of information about movement of equipment.	*The negative impact on habitat 6210* must be avoided and damaging the habitat is not allowed. *The movement of people and equipment, waste storage and other activities during construction as well as maintenance work must be organized outside this habitat type.	No impact
6280*	No impact	-	-	*The habitat is located outside the direct impact area. The possible movement of equipment during construction work within habitat can damage the habitat. The spatial extent of possible damage is not possible to determine due to lack of information about movement of equipment.	*The negative impact on habitat 6280* must be avoided and the damaging of habitat is not allowed. *The movement of people and equipment, waste storage and other activities during construction as well as maintenance work must be organized outside this habitat type.	No impact

6.7.3.2 Assessment of impact on the Pakri Birds Directive Site

Impact during construction

During construction, the potential negative impact on the birds in the Pakri Birds Directive site can be expressed as a result of noise. The noise generated can disturb birds and deter them from their feeding and nesting locations. The longer the duration of noise, the greater the impact on birds. Noise spreads significantly more extensively in the water than in the air. The impact of underwater noise on birds has been studied very little. It is probable that birds do not hear well under water. However, a constant loud noise or sound waves caused by blasting can significantly disturb birds feeding under water and deter them. Underwater noise mostly impacts birds diving for food (Grebes, Divers, Cormorant, Black Guillemot, Ducks) and can disturb their normal feeding, reduce their ability to catch food and/or reduce the depth of diving. Noise disturbance is more significant during the nesting period, when the slightest disturbance can affect nesting birds. As the construction work will last during a specific period and it will constantly move further along the pipeline, then the impact of noise is **assessed as local and temporary, disappearing once construction work has been completed.**

An indirect negative impact on the water condition can be caused by the suspended particulate matter generated during construction work. Suspended matter can reduce water transparency, which can in turn hinder birds feeding in the water. Re-suspended particles can also have a negative impact on the benthic fauna, fish and invertebrates functioning as a basis of food for seabirds. The impact is local and short-term, and therefore **it is considered insignificant.**

Construction of the Balticconnector pipelinewill cause a temporary decrease in fish and benthos in the area. Benthic fauna by the pipeline will be destroyed. Some fish may leave the disturbance area due to noise. This has an indirect negative impact on seabirds feeding on these animal groups. Taking into account the fact that these impacts are temporary and reversible, the impact of temporary reduced food basis on birds is assessed as **insignificant.**

Impact during operation and maintenance

The impact on birds during operationand maintenance is limited. The main aspect here is the movement of ships realting to pipeline maintenance in the area, which causes noise, visual disturbance, and increases the risk of oil pollution. Repair and maintenance is conducted only when necessary, and this traffic will probably not be very frequent, and does not deviate from other vessel traffic in the area. Therefore, the negative impact on birds linked to operating Balticconnector is assessed as **insignificant.**

Table 6-37. Assessment of significant impact – Velvet Scoter.

Type of impact	Reasoning	Evaluation of significance
Loss of habitat area	The habitat area of the Velvet Scoter will not decrease during construction. The area of feeding on the seabed can decrease, but this will recover once the work has been completed.	Impact is not significant
Fragmentation	As a result of tdisturbance, there can be some fragmentation of flocks during the gathering period and migration stops, but this will only last during two years, until the construciton wrk has been completed. A mitigation measure has been proposed to limit this impact.	Before: Moderate impact After: Little impact/temporary
Disturbance	The highest level of disturbance can occur during the gathering period of the Velvet Scoter in early spring. The duration of the disturbance is limited to the construction time of up to 2 years. A mitigation measure has been proposed to limit this impact.	Before: Moderate impact After: Little impact/temporary
Population density	The population density of the Velvet Scoter at Lahepere Bay can temporarily decrease due to the construction work because birds can relocate as a result of the disturbance. The duration of the impact is limited to the construction time of 2 years and is not constant.	Before: Moderate impact After: Little impact/temporary
Water quality	Water transparency decreases in different sections of the pipeline for a limited number of days while work is conducted. This can limit the vision range of birds feeding on benthic fauna on the seabed, but the impact is insignificant due to its short duration.	Impact is not significant

Table 6-38. Assessment of significant impact - Goosander.

Type of impact	Reasoning	Evaluation of significance
Loss of habitat area	No significant decrease in habitat or feeding area.	Impact is not significant
Fragmentation	As a result of the disturbance, there can be some fragmentation of bevies during the gathering period and migration stops but this will only last two years, until construction work has been completed. A mitigation measure has been proposed to limit this impact.	Little impact/temporary
Disturbance	Disturbance due to construction work can occur during the nesting period of the Goosander. A mitigation measure has been proposed to avoid this impact. Overwintering and migrating birds can also be disturbed during the construction time. The duration of the disturbance is limited to the construction time of up to 2 years. A mitigation measure has been proposed.	Before: Moderate impact After: Little impact/temporary
Population density	The population density of the Goosander at Lahepere Bay can temporarily decrease due to construction work because the birds can relocate as a result of the disturbance. The duration of the impact is limited to the construction time of 2 years and it is not constant.	Little impact/temporary
Water quality	Water transparency decreases in different sections of the pipeline for a limited number of days while work is conducted. This can limit the vision range of Goosanders feeding on fish in the water column, but the impact is insignificant due to its short duration.	Impact is not significant

Table 6-39. Assessment of significant impact - Long-tailed Duck.

Type of impact	Reasoning	Evaluation of significance
Loss of habitat area	The habitat area of the Long-tailed Duck will not decrease during construction. The area of feeding on the seabed can decrease but this will be restores once construction has been completed.	Impact is not significant
Fragmentation	As a result of the disturbance, there can be some fragmentation of bevies during the gathering period and migration stops, but this will only be for two years, until the construction work has been completed. A mitigation measure has been proposed to limit this impact.	Before: Moderate impact After: Little impact/temporary
Disturbance	The highest level of disturbance can occur during the gathering period in autumn and early spring. The duration of the disturbance is limited to the construction time of up to 2 years. A mitigation measure has been proposed.	Before: Moderate impact After: Little impact/temporary
Population density	The population density of the Long-tailed Duck at Lahepere Bay can temporarily decrease due to construction work because birds can relocate as a result of the disturbance. The duration of the impact is limited to the construction time of 2 years and it is not constant.	Before: Moderate impact After: Little impact/temporary
Water quality	Water transparency decreases in different sections of the pipeline for a limited number of days while construction work is conducted. This can limit the vision range of Long-tailed Duck feeding on benthic fauna, but the impact is insignificant due to its short duration.	Impact is not significant

Table 6-40. Assessment of significant impact - Mute Swan - Swan.

Type of impact	Reasoning	Evaluation of significance
Loss of habitat area	No significant decrease in habitat or feeding area.	Impact is not significant
Fragmentation	As a result of the disturbance, there can be some fragmentation of bevies during the gathering period and migration stops but this only occurs for two years, until construction work has been completed. A mitigation measure has been proposed to limit this impact.	Impact is not significant
Disturbance	Disturbance due to construction work can occur during the nesting period of the Mute Swan. A mitigation measure has been proposed to avoid this impact. Overwintering and migrating birds can also be disturbed during construction work. The duration of the disturbance is limited to construction work of up to 2 years. A mitigation measure has been proposed.	Little impact/temporary
Population density	The population density of the Mute Swan at Lahepere Bay can temporarily decrease due to construction work because birds can relocate as a result of the disturbance. The duration of the impact is limited to the construciton time of 2 years and it is not constant.	Little impact/temporary
Water quality	Water transparency decreases in different sections of the pipeline for a limited number of days while construction work is conducted. This has no impact on Swans feeding on benthic flora in shallow water.	Impact is not significant

The impact on Common Goldeneye and Greater Scaup is addressed jointly as the impact of planned activities is the same.

Table 6-41. Assessment of significant impact - Common Goldeneye and Greater Scaup.

Type of impact	Reasoning	Evaluation of significance
Loss of habitat area	The habitat area of Common Goldeneye will not decrease during construction. The area of feeding on the seabed can decrease but this will be restored once the work is completed.	Impact is not significant
Fragmentation	As a result of the disturbance, there can be some fragmentation of bevies during the gathering period and migration stops but this only occurs for a max two years, until construction work has been completed. A mitigation measure has been proposed to limit this impact.	Before: Moderate impact After: Little impact/temporary
Disturbance	Disturbance due to construction activity can occur during the migration stops and overwintering period of the Common Goldeneye. The duration of the disturbance is limited to the construction time of up to 2 years and it is not constant. A mitigation measure has been proposed.	Before: Moderate impact After: Little impact/temporary
Population density	The population density of the birds migrating through and overwintering at Lahepere Bay can temporarily decrease due to construction work but this is temporary, limited to the construction time of 2 years and is not constant.	Before: Moderate impact After: Little impact/temporary
Water quality	Water transparency decreases in different sections of the pipeline for a limited number of days while construction work is conducted. This can limit the vision range of Common Goldeneye feeding on benthic fauna but the impact is insignificant due to its short duration.	Impact is not significant

Table 6-42. Assessment of significant impact - Mallard.

Type of impact	Reasoning	Evaluation of significance
Loss of habitat area	No significant decrease in habitat or feeding area.	Impact is not significant
Fragmentation	As a result of the disturbance, there can be some fragmentation of bevies during the gathering period and migration stops but this only occurs for 1 or at most 2 years, until construction work has been completed. A mitigation measure has been proposed to limit this impact.	Impact is not significant
Disturbance	The disturbance due to construction work can impact Mallards during the nesting period as well as during thewinter gathering period. The duration of the disturbance is limited to the construction time of 2 years and it is not constant. A mitigation measure has been proposed.	Little impact/temporary
Population density	The population density of the Mallards present at Lahepere Bay practically all year can temporarily decrease due to construction work but this is temporary, limited to the construction time of 2 years and is not constant. Mallard is a very common species in Estonia (also in the cities) and its population density at Lahepere Bay is not very high when compared to, for example, Pakri Bay.	Little impact/temporary
Water quality	Water transparency decreases in different sections of the pipeline for a limited number of days while the construction work is conducted. This has no impact on Mallards feeding on benthic flora in shallow water.	Impact is not significant

The impact on common Eurasian Wigeon, Great Crested Grebe and Common Eider is addressed jointly as the impact of planned activities is the same.

Table 6-43. Assessment of significant impact - Eurasian Wigeon, Great Crested Grebe, and Common Eider.

Type of impact	Reasoning	Evaluation of significance
Loss of habitat area	No significant decrease in habitat or feeding area.	Impact is not significant
Fragmentation	As a result of the disturbance, there can be some fragmentation of bevies during the gathering period and migration stops but this only occurs for two years, until construction work has been completed. A mitigation measure has been proposed to limit this impact.	Before: Moderate impact After: Little impact/temporary
Disturbance	The disturbance due to construction work can impact the Great Crested Grebe during the nesting period. A mitigation measure has been proposed to avoid this impact. Migrating birds can also be disturbed during construction. The duration of the disturbance is limited to the constructiof up to 2 years. A mitigation measure has been proposed.	Before: Moderate impact After: Little impact/temporary
Population density	The population density of the birds migrating through Lahepere Bay can temporarily decrease due to construction work but this is temporary, limited to the construction time of 2 years and is not constant.	Before: Moderate impact After: Little impact/temporary
Water quality	Water transparency decreases in different sections of the pipeline for a limited number of days while construction work is conducted. This can limit the vision range of birds feeding on benthic fauna, but the impact is insignificant due to its short duration.	Impact is not significant

Table 6-44. Assessment of significant impact - Black Guillemot.

Type of impact	Reasoning	Evaluation of significance
Loss of habitat area	No significant decrease in habitat or feeding area.	Impact is not significant
Fragmentation	Fragmentation is dangerous during the nesting period but a mitigation measure has been proposed for this purpose. During the non-nesting period the Black Guillemot is not very common at Lahepere Bay and does not gather in big bevies.	Moderate impact Impact is not significant
Disturbance	Disturbance due to construction work can impact the Black Guillemot during the nesting period. A mitigation measure has been proposed to avoid this impact. Migrating birds can also be disturbed during construction. The duration of the disturbance is limited to the construction time of up to 2 years. A mitigation measure has been proposed.	Before: Moderate impact After: Little impact/temporary
Population density	The population density of nesting birds can decrease as a result of the disturbance caused by construction work. A mitigation measure has been proposed to avoid this. Very few birds are present at Lahepere Bay during the non-nesting periods.	Moderate impact Impact is not significant
Water quality	Water transparency decreases in different sections of the pipeline for a limited number of days while construction work is conducted. This can limit the vision range of birds feeding in the water column and on the seabed, but the impact is insignificant due to its short duration.	Impact is not significant

6.7.4 Cumulative impact

The potential cumulative impact of the Balticconnector gas pipeline on Pakri habitats and birds directive sites addressed together with the planned LNG terminal, which is located within the impact area of the landfall of ALT EST 2. In addition to other named information sources, the approved report of the strategic impact assessment of the thematic plan for Paldiski LNG terminal has been used to assess the cumulative impact.

Under Paldiski City Council decision No 17 dated January 20, 2010, the thematic plan of Paldiski LNG terminal was initiated, the purpose of which is to specify and amend the comprehensive plan of Paldiski in relation to planning the LNG terminal. The planning area consists of an impact area (Paldiski municipality, Pakrineeme, cadastral register number 58001:003:0271) with a radius of 750 m from the location of the planned terminal, and nearby land units of a total area of 220 ha. The strategic environmental impact assessment for the thematic plan was initiated by the same decision. (*OÜ E- Konsult 2012*) SEA has been approved by the Environmental Board on July 19, 2012 by document no HJR 6-8/12/30799-48, and the thematic plan has been enacted by decision No 51 dated September 27, 2012 by Paldiski City Council.

By order No 297 dated October 1, 2012 Paldiski City Government initiated the relevant detailed plan „Initiating the detailed plan for the mainland part of Paldiski LNG terminal and not initiating the environmental impact assessment", which was established by decision No 21 dated May 22, 2014 by Paldiski City Council.

In 2013, Pakrineeme Sadama OÜ submitted an application for special use of water in order to construct a pier, based on which the Environmental Board initiated (*23.01.2013, by letter no 7-6/13/996-2*) initiated the environmental impact assessment for the activity. The SEA report is being compiled.

Potential cumulative impact on the protection aims of Pakri Habitats Directive Site

Based on the report of "Strategic impact assessment of the thematic plan for Paldiski LNG terminal", the impact area of the Paldiski LNG terminal will include two protection aims of Pakri habitat area – underwater sandbanks and reefs. The thematic plan area of the LNG terminal also includes a habitat of sand pink (*OÜ E-Konsult 2011*).

Table 6-45. Possible cumulative impacts on Pakri habitats directive site.

Protection aim	Description of cumulative impact	Significance of the impact
Sand pink	This habitat is not present in the impact area of the landfall location of ALT EST 2.	No impact
Sandbanks 1110	Both planned activities can damage the habitat and cause a decrease in their area. Sediments and resuspended particles moved during the construction work can cause a short-term decrease in water quality, and the particles can settle on the habitat.	The impact of resuspended particles is not significant, it is short-term, and spatially limited. The work conducted for constructing the LNG pier is not extensive, and based on the SEA report it will not cause a significant increase in resuspended particles. The cumulative impact due to damage to the habitat is not significant if proper mitigation measures described in chapter 6.7.5 are applied.
Reefs 1170	Based on the SEA report of the LNG thematic plan, the pier construction does not have any impact on this habitat. However, based on modeled data on these habitats there is reason to believe that the construction of the LNG terminal pier can damage reefs and cause a decrease in their area in the region of Pakrineeme. Sediments and resuspended particles moved during the construction work can cause a short-term decrease in water quality, and the particles can settle on the habitat.	The impact of resuspended particles is not significant, it is short-term, and spatially limited. The cumulative impact due to damage to the habitat is not significant if proper mitigation measures described in chapter 6.7.5 are applied.

Omissions and inaccuracies

1. This report uses sea habitats map layers modeled in 2014 for Natura 2000 relevant assessment, however, the SEA of LNG terminal is based on the data of inventory conducted by TU Marine Institute in 2009 (*TÜ Eesti MereInstituut 2009*), and therefore the data is different.
2. The Nature relevant assessment of the SEA report of LNG does not address habitat types 6280* and 1230, which are located within the Pakri Natura 2000 site and the impact area of the LNG terminal based on the map layers of EELIS: Environment Agency (*EELIS 2014*). There is no impact from Balticconnector pipeline construction on these habitats if mitigation measure No 11 described in section 6.7.5 is applied.

Potential cumulative impact on the protection aims of the Pakri bird area

Cumulative impact on the Pakri bird area can be present in the area of ALT EST 2 at Pakrineeme due to the construction of the LNG terminal.

Table 6-46. Possible cumulative impacts on Pakri Birds Directive site.

Impact	Description	Mitigation measures
Noise	If the LNG terminal and Balticconnector ALT EST 2 are simultaneously constructed at Pakrineeme, there is potential temporal cumulative impact on birds caused by higher and more extensive noise.	To mitigate the impact it is necessary to avoid conducting the construction projects simultaneously.
Re-suspended particles, decrease in water transparency	Short-term cumulative impact at Pakrineeme can result from re-suspended particles and a decrease in water transparency if the construction work for both projects is conducted simultaneously in the water. The decrease in water quality can cause difficulties for sea birds feeding in the area.	To mitigate the impact it is necessary to avoid conducting the construction projects simultaneously.
Damage to the habitat and decrease in its area	Both construction projects can damage benthic habitats and decrease their area at Pakrineeme. The benthic fauna is a source of food for the Long-tailed Duck.	To mitigate the cumulative impact, it is necessary to apply proper mitigation measures listed in section 6.7.5

6.7.5 Mitigation measures

1. In both alternative routes, there is a probable significant negative impact to habitat 1110 in terms of the habitat being split into two parts. In ALT EST 1, the splitting will occur for 4.3 km and in ALT EST 2 for approx. 1 km. This is not a priority habitat, but nevertheless mitigation measures are recommended. For mitigation, the same material excavated from a habitat during construction can be used for backfilling the trenchin the extent of habitat types listed in the Habitats Directive to avoid splitting and permanent damage to a valuable habitat. This would allow for the restoration of the habitat within a few years, and reduce the impacts to a moderate or insignificant level. It is recommended to monitor the habitats within Lahepere Bay yearly for minimum of five years after construction until an acceptable recovery level of habitats.
2. In alternative route ALT EST 2, there is a probable significant negative impact to priority habitat 9180*, through vibration from drilling possibly causing changes in the micro-terrain. The construction methods should be planned to minimize the impact.
3. In both alternatives, along the onshore section of the pipeline, the negative impact on priority habitats 6210* and 6280* must be avoided and the damaging of habitat is not allowed. In ALT EST 1 and ALT EST 2, these habitats lie outside the Natura 2000 site and in the indirect impact zone of the pipeline. In order to make sure that there are no significant impacts to these habitats, the construction (including transportation, etc.) should be planned so that the construction sites do not extend into these habitats or their immediate vicinity.

As general mitigation measures the following can be recommended:

4. Dredged sediment or soil (at sea as well as on mainland) can be stored for a short period in order to use it later for backfilling the trench, if possible, thus guaranteeing the preservation of characteristics common to the habitat types and the best possible restoration of habitats. On thr mainland, the soil can be transported for short distances, if necessary.
5. During construction work at sea, a monitoring of dispersion of suspended matter must be performed, to prevent this spreading in a concentration > 10 g/m^2 over extensive area.
6. The logging, excavation, the movement of people and equipment, waste storage and other activities during construction as well as maintenance work must be organised outside priority habitats and not damage these habitats nor cause a deterioration to their condition.
7. There is a population of scarce fritillary occurring in the vicinity, but outside the Natura 2000 site, in ALT EST 1. In order to avoid impacts on the population, it is recommended to use plants suitable for caterpillar food in restoration of the land along the route of the gas pipeline.
8. No significant impacts to birds are likely. In any case, in both alternative routes, it is recommended to monitor breeding birds and wintering birds during construction work, and to suspend construction if a significant impact appears likely. It is to be noted that construction is likely to have some effects on the behavior of birds, but it is temporary and takes place during one season only.
9. Construction activities within the Pakri Birds Directive Site must be avoided in the birds' nesting period from the 1 April to the end of July in the case of implementation of ALT EST 2.
10. Construction activities within Pakri birds directive site should be avoided in the birds nesting period from April 15 to July 15 in the case of implementation of ALT EST 1 in the Lahepere Bay (pipeline section 81.3 km–79 km).

6.7.6 Omissions and possible inaccuracies

- Modeled habitat maps have been used to assess sea habitats. These can contain inaccurate data on the location and area of habitats, but at the moment they are the best available sources of information.
- Currently valid "Protection arrangement plan of the Pakri Landscape Protection Area and Special Conservation Area 2007–2016" does not cover sea habitats, surface areas under protection, and risk factors, which would be good supporting material for the expert compiling the assessment.
- The chemical analysis of sediment in Lahepere Bay conducted as a part of the sea environment study of Balticconnector (*TTÜ Meresüsteemide Instituut 2013*) exclusively covers the upper layer of sediment (20 cm), and therefore pollution can be assessed only based on this data.
- The exact construction site of the microtunnel (shafting jack and MTBM) as well access roads to the site are not known.
- It is not known if marking of microtunnel route is compulsory in a way that trees must be cut.

6.7.7 Conclusions

The impacts on habitats and protected areas from construction, comissioning and operation of the planned Balticconnector natural gas pipeline are summarized in Table 6–47 below. There are cases, where significant impacts on habitats cannot be excludes.

Table 6-47. Summary of impacts on habitats within Pakri habitats directive site without mitigation measures.

Type of habitat	ALT EST 1			ALT EST 2		
	Construction	Commissioning	Operation	Construction	Commissioning	Operation
1110	High negatiive impact on habitat is not excluded	Low	Low	Moderate	Low	Low
1170	No impact	No impact	No impact	Low	Low	Low
1230	No impact	No impact	No impact	Low/Moderate	No impact	Low
9180*	No impact	No impact	No impact	High negative impact not excluded	No impact	High negatiive impact not excluded
6210*	No impact	No impact	No impact	Low/No impact	No impact	Low/No impact
6280*	No impact	No impact	No impact	Low/No impact	No impact	Low/No impact

Both alternative routes of the Balticconnector gaspipe run through the Pakri Habitat Directive and Birds Directive Sites. Significant impacts without implementation of mitigation measures can not be excluded to concern habitat 1110 in both alternatives (but at different lengths). This is not a priority habitat, and mitigation measures (refilling by same sediment) will reduce the impact to insignificant.

In ALT EST 2, significant impact cannot be excluded for the priority habitat 9180*, because it cannot be predicted how microtunneling will affect the soil structure, roots of plants or water regime. The significant impact to priority habitats 6210* and 6280* (situated outside of Natura 2000 site) in the ALT EST 2 area can be avoided by making sure construction activities do not take place in the immediate vicinity of these sites. Construction and operation will not affect priority habitats in the ALT EST 1 area.

The impact of planned construction work on the bird species defined as the protection aim of the Natura 2000 birds area is insignificant to moderate. In order to limit moderate impact, it is necessary to apply mitigation measures. It is important to avoid negative impact on Black Guillemot whose only known nesting location in Estonia is located on Pakri cape, which is within the impact area of ALT EST 2. In order to avoid negative impact on overwintering and nesting waterbirds, it is advisable to avoid hydrotechnical work during the gathering period of overwintering waterbirds.

The project is estimated to have insignificant impact to the integrity of the Natura 2000 site. Some habitats, and possibly species, face impacts which can be reduced by appropriate mitigation measures. The potentially high impact on habitat 1110 in ALT EST 1 area can be excluded by implementation of mitigation measures. At the moment the impact on habitat 9180* in the ALT EST 2 area is not excluded due to lack of information about marking of the microtunnel route on the mainland and an exact location of microtunnel head.

The ALT EST 1 is assessed as alternative with less impact on Pakri habitats directive site compared with ALT EST 2.

6.8 Decommissioning

6.8.1 Assessment methods and assessment uncertainties

The environmental impacts of decommissioning were assessed on the basis of impacts during construction and experiences from the impacts of the decommissioning of corresponding projects. The impacts of the discontinuation of operation are described to the extent possible at this stage.

The time of decommissioning is difficult to estimate. The possible decommissioning will take place in several decades' time, and there is no certainty today on the construction technologies available then. Issues such as water quality and state of the natural environment cannot be assessed specifically at this point either. For reasons including these there are uncertainties in the assessment. Post-decommissioning measures will be determined in accordance with the legislation in force at any given time.

6.8.2 Environmental impacts assessed

The gas pipeline will be an energy transmission system designed for continuous use, with its condition maintained continuously. The Balticconnector pipeline's operational life is expected to be 50 years. A decommissioned pipeline is typically left in place. Decommissioning will take place using methods available at that point in time and in compliance with international regulations and recommendations as well as the legislation in force in Finland and in Estonia at that time.

6.8.2.1 Isolation and cleaning

In the initial phase of decommissioning, pipeline isolation and cleaning will take place. A mechanical plug device may be applied for actual isolation from onshore gas grids. The main option for pipeline isolation and cleaning is the isolation pig train drive medium, which will be inhibited seawater.

By performing a pre-decommissioning cleaning operation, any loose material such as corrosion products, magnetite or soft scale can be removed together with the residual condensate.

6.8.2.2 Alternative methods for decommissioning

Leaving the offshore pipeline on the seabed

The pipeline can be left on the seabed. Activities required for this decommissioning method involve:

- filling the pipeline with seawater or inhibited seawater;
- sealing off the pipeline ends; and
- performing regular inspections of the pipeline.

In addition to the above-mentioned activities, the pipeline may be trenched and/or rock-covered to protect shipping, fishing and navy activities against disturbance caused by the pipeline. Leaving the offshore pipeline on the seabed is not estimated to have significant impacts on water quality, marine environment or safety.

Recovering the offshore pipeline from the seabed

Another alternative for decommissioning is to recover the pipeline from the seabed. Activities required for this decommissioning method involve:

- dredging, jetting and removal of rock to expose the pipeline;
- cutting the pipeline in suitable sections for recovery;
- removing coating;
- onshore disposal;
- weight- and anti-corrosion coating removal;
- recycling steels; and
- using coatings as landfill.

The recovery of the gas pipeline from the seabed will result in a significantly larger amount of adverse environmental impacts than leaving it on the seabed. The environmental impacts of recovery will be almost equal in type and extent to those arising from the construction of the offshore pipeline described in this EIA report.

Decommissioning of the onshore pipeline

As regards onshore pipes, the environmental impacts of decommissioning will depend on whether only the above-ground structures of the natural gas transmission pipeline (such as signposts and equipment at stations) or both the above- and underground structures (including transmission pipeline) will be removed. In this case the removal of the underground transmission pipeline will result in a significantly higher level of adverse environmental impacts.

The removal of the above-ground structures of the pipeline would require the disconnection of the pipeline section from the rest of the network. This will call for excavation work. Decommissioned transmission pipelines can, however, be reused for purposes such are protective piping for various municipal engineering pipes or cables. The impacts of decommissioned underground transmission pipelines on soil as well as groundwater and surface waters will be similar to those of transmission pipelines in operation. Perforation corrosion in transmission pipelines left underground is highly unlikely. If this was, however, to take place, the worst consequence would be a small local indentation. The impacts of this would be low and not necessarily visible to the eye. If the transmission pipeline is left underground, it may need to be dug up at a later date in the section in question due to other construction.

If the above-ground structures as well as the underground transmission pipeline are removed after decommissioning, the impacts of the earthworks and demolition work will be almost as large as those during the construction of a new natural gas transmission pipeline.

The removal of the offshore and onshore pipeline sections as well as related structures will be decided specifically for each case and in compliance with the statutory obligations in force at that time. The statutory obligations in force 50 years from now cannot, however, be assessed specifically at the moment. There is no significant difference between the routing alternatives as regards decommissioning.

6.9 Exceptional and accident situations

The assessment of the impacts of exceptional and accident situations along the pipeline route in Finland and Estonia during the operation of the gas pipeline is based on a quantitative risk assessment conducted for the project *(Ramboll 2014b)*. The assessment covers the risks related to human safety and structural integrity concerning Estonia for one route alternative and is based on the occurrence frequency of pipeline damage resulting in an offshore gas leak calculated using a mathematical model. Offshore gas leaks result in a cloud of gas on the sea surface, with the risks posed to human safety assessed on the basis of the size of the cloud for various sizes of pipeline damage. The amount of pipeline damage depends on issues such as the structure of the gas pipeline and environmental conditions. The occurrence frequency of pipeline damage in this risk assessment usually equals the occurrence frequency of the release of a gas cloud.

The risk assessment conducted for the Nord Stream project was utilized in the identification of exceptional and accident situations and impact assessments during pipeline installation *(Nord Stream 2009)*.

6.9.1 Impact of construction activities

The most significant risks relating to the construction of the natural gas pipeline comprise the collision of installation vessels participating in pipelaying with other vessels as well as any munitions and barrels containing hazardous substances found in the seabed in the construction area.

Safety incidents identified

The following accident and disturbance situations have been identified for natural gas pipeline construction:

- installation vessel collision with a passing ship;
- vessel oil spill;
- fire on board an installation vessel;
- grounding of an installation vessel;
- sinking or capsize of an installation vessel;
- oil spills in conjunction with bunkering;
- risks relating to munitions and barrels containing hazardous substances found on the seabed.

Environmental impacts and probability of accident and disturbance situations

The accident and disturbance situations relating to the construction of the ALT EST1 and ALT EST2 project alternatives are corresponding to those in the construction of the Nord Stream gas pipeline constructed earlier. The Balticconnector project will, however, involve more seabed intervention and related rock transport and explosions.

The rate of vessel traffic relating to pipeline installation will be rather high. There will be three pipe transport vessels, a pipelaying vessel and vessels relating to seabed intervention moving in the construction area and lanes leading into it (see section 6.5.15.1.1). The collision of a pipelaying vessel, pipe transport vessel or vessel participating in seabed intervention with a passing ship is unlikely but possible. The consequences correspond to those of other collisions of corresponding vessels. There are around 2,000 vessels at sea in the Baltic Sea at any given time. The risk of accident caused by the Balticconnector project is very small as the increase in vessel traffic arising from the project is small. The number of vessel collisions in the Gulf of Finland has decreased considerably in the past years, with no collision accidents taking place in 2012 *(HELCOM 2014, RKTL 2012)*.

A vessel oil spill can consist of shipping fuel or crude oil transported by a tanker. The majority of oil-spillage accidents are caused by a vessel's fuel spilling into the sea as a result of an incident such as grounding. In 2004–2010 there were 4–13 accidents in the Baltic Sea resulting in an oil spill. The increased risk of oil spill caused by the Balticconnector project is very small as the increase in vessel traffic arising from the project will be small.

The impacts of oil leaking from a ship depend especially on the size of the oil spill but also on the type of oil, time of year, weather conditions and whether or not the oil stays off the shore or washes up on the shore. Oil-related accidents can result in various degrees of shore pollution, damage to birds and coverage of plants and cause damage to animals on land when washed ashore as well as suffocating or contaminating underwater plant and animal communities *(Oilrisk)*. Oil spills of fuel used by vessels amount to spills of tens or a maximum of 100–200 tonnes, while tanker spills may be tens of thousands of tonnes *(Finnish Association for Nature Conservation 2014, RKTL 2012)*.

In conjunction with geophysical surveys conducted on the gas pipeline corridor *(MMT 2014 and 2006)*, a total of 48 items were found over the entire study corridor that are assessed to be man-made and that can, for example, be metal waste, barrels or munitions. Of these 8 are assessed to possibly be munitions, with 2 of these located in the exclusive economic zone of Finland and 6 in that of Estonia. The munitions will be cleared before the construction of the gas pipeline *(MMT 2014and 2006)*.

There may also be barrels containing substances that are harmful to the environment along the routing and study corridor of the planned gas pipeline. If a barrel is damaged during gas pipeline installation or maintenance work, its contents may leak into the sea. Any environmental damage will depend on the harmfulness of the substances in the barrel. Barrels will be removed before the construction of the gas pipeline.

Accident prevention

The prevention of safety incidents is the primary goal set for planning. Planning will take place in compliance with legislation as well as safety and occupational health and safety rules. Efforts will be made to prevent vessel collisions and groundings through traffic control (see section 6.5.15.1).

The detailed mapping of munitions and barrels is yet to take place. To prevent any risks relating to munitions and barrels in the gas pipeline corridor, more detailed underwater studies involving the more detailed mapping of munitions and barrels will take place before the installation of the gas pipeline. The disposal of munitions and barrels will be negotiated with the relevant national authorities. The munitions clearance plan will be drawn up with a view to minimizing any impacts on fish, birds and mammals. In addition, the necessary safety zones will be established and other vessels notified of the schedules and methods of munitions clearance in the appropriate manner to avoid the risk of accidents.

The table below presents a summary of accidents relating to gas pipeline construction, their consequences and possible impacts, as well as measures taken in preparation.

Table 6-48. Most significant possible accident situations, their consequences and possible impacts as well as measures taken to prevent accidents.

	Consequence	Possible impact and probability	Prevention measures
Alternatives ALT EST1 and ALT EST2			
Vessel collision	Vessel damage, sinking or fire	- personal injuries - economic loss - spread of flue gases into the environment from a fire - oil spill - chemical spill	- safety zones - fire and oil spill response equipment - personnel training
Grounding of installation vessel	Oil spill	- shore oil pollution - birds fouled by oil - other environmental damage	- safety zones - fire and oil spill response equipment - personnel training
	Vessel damage or sinking	- personal injuries - economic loss - Oil spill	- safety zones - oil spill response equipment - personnel training
Explosion of munition on the seabed	Pressure wave	- personal injuries - economic loss - damage to fish, birds and mammals	- more specific mapping of munitions in advance
Leakage of barrel on the seabed	Chemical spill into the sea	- environmental damage	- more specific mapping and removal of barrels in advance
Explosion accident during seabed intervention	Pressure wave	- personal injuries - economic loss	- design and planning

6.9.2 Impacts during operation

6.9.2.1 Occurrence frequency of offshore gas pipeline leaks

Possible damage to the gas pipeline and resulting pipeline malfunction could have consequences to human safety. The sections where the pipeline must be protected (section 3.4.1) to prevent pipeline damage were identified in the risk assessment conducted for the Balticconnector project (*Ramboll 2014b*). The quantitative assessments of the risk presented below therefore represent the magnitudes of risk without any protective measures, which are already included in the pipeline design. The measures to protect the pipeline will reduce the risk to an acceptable level, whereby the frequency of accidents at this stage of the design process may be a maximum of once in 100,000 years per 1 km of pipeline. The premise applied in the design and protection of the gas pipeline is for the above-mentioned risk not be exceeded.

Damage to the gas pipeline can be caused by the following:

- contact with an anchor (emergency anchoring or anchor dragging);
- contact with trawling gear;
- vessel sinking;
- vessel grounding;
- damage caused by ice formation.

Anchoring

Emergency anchoring may be required in a situation where a vessel begins to drift due to a mechanical problem caused by an issue such as a power cut and the vessel loses propulsion. If an anchor of a drifting vessel is lowered on top of the gas pipeline, it may hit the pipeline. In the risk assessment this situation is referred to as a 'dropped anchor'. An anchor could also damage the gas pipeline in a situation where the anchor is lowered before the pipeline but comes in contact with or gets caught in the gas pipeline ('dragged anchor'). An anchor hitting the gas pipeline may cause an indentation the size of which determines whether or not gas will be released from the pipeline. In the risk assessment, mathematical models were used to calculate the probability of contact between an anchor and the gas pipeline and a resulting gas leak. Issues taken into consideration in the model included:

- vessel traffic (routes, number and size of vessels);
- gas pipeline characteristics (routing, trenches, water depth).

The occurrence frequency of malfunctions in the gas pipeline before any protective measures obtained for the entire length of the pipeline for the various alternatives is 4.15–4.21 * 10^{-3} years, which corresponds to a return period of 238–241 years. The probability of pipeline damage is the highest in the pipeline sections between KP 36–39 and 44–47, which are located to the north of the mid-section of the pipeline at a distance of around 2–5 km and to the south at around 3–7 km (Figure 3–1) *(Ramboll 2014b)*.

Vessel sinking

A vessel sinking while crossing the gas pipeline could damage the pipeline by touching it directly or when hitting the seabed. The probability of a vessel sinking was obtained by using IMO[1] data to calculate the general probability for the sinking of a cargo ship per hour traveled. IMO statistics for 2002 and 2003 on serious and very serious casualties were used as the initial data. According to IMO data, in 2002 there were 30 foundering (sinking or submerging) casualty events while in 2003 the figure was 34. The distance traveled by the vessels was taken into consideration when calculating the probability of a vessel sinking in the Balticconnector gas pipeline area. The probability of a vessel sinking without any pipeline protection measures is for the entire length of the pipeline for the different alternatives 5.61–5.71 * 10^{-5} years, which corresponds to a return period of 17,513–17,825 years *(Ramboll 2014b).*

Vessel grounding

The grounding of a vessel in the coastal area could without any protective measures pose a risk of damage to the gas pipeline. The protection of the pipeline with a trench will be sufficient to reduce the risk posed by vessels grounding to an acceptable level. The laying of the pipeline in a trench near the landfalls must be designed particularly carefully. In Finland the landfall will be close to the fairway leading to the Port of Ingå and close to a lighthouse used by vessels approaching the port for navigation. If a vessel at that point fails to take the next turn in time, grounding close to the gas pipeline is possible. For safety reasons the pipeline will be placed in a trench in that section and also be protected with a layer of rock *(Ramboll 2014b and 2006)*.

Probability of the different malfunctions combined

The probability of damage to the gas pipeline caused by the different factors is the highest in pipeline sections KP 37–39 and KP 44–46 mainly due to the large volume of vessel traffic crossing the pipeline *(Ramboll 2014b)*. Without any protective measures an accident would take place in this alternative once in every 234–238 years. In the risk assessment those sections that need to be protected to keep the risk at an acceptable level, i.e. at a maximum accident frequency of once in 100,000 years per 1 km of pipeline, were identified. According to current plans, the pipeline will be designed and protected in a manner whereby the above-mentioned risk will not be exceeded.

Ice formation

In the winter ice accumulation may take place in coastal areas, creating pressure on the seabed. The pipeline could be damaged by ice if not placed appropriately in a trench. Ice accumulation takes place when ice is pushed by strong winds and currents from offshore areas towards the coast. At depths of water exceeding 20 m ice accumulation is not expected to be a problem for the gas pipeline as the maximum height of ice ridges observed accumulating in the area has been 15 m. In areas where ice formation is assessed to pose a risk of pipeline damage the gas pipeline will be protected by trenching. According to the preliminary plan, these sections total around 20 km, mainly in sections KP 7–23 near Ingå and KP 76–80 near Paldiski. *(Ramboll 2014a and b)*

Trawling

According to analyses conducted for other gas pipeline projects, pipelines are able to withstand the impacts of trawling gear touching a pipeline or being pulled over it. The highest impact on a pipeline is seen in the event of trawling gear becoming snagged under the pipeline. This can only take place in those sections where a freespan is high. The components of trawling gear are weak enough to break before damage to the pipeline occurs *(Ramboll 2009)*.

6.9.2.2 Consequences of offshore gas pipeline leak

The consequences of a leak from the gas pipeline were examined concerning human safety.

A possible consequence of an offshore gas leak is the formation of a gas cloud close to the surface of the sea. If the concentration of gas in the cloud formed is appropriate for ignition, an ignition source (such as a passing ship) may ignite the cloud and cause an accident involving humans.

Gas released from a damaged offshore gas pipeline will spread into the surrounding water column in a conical formation moving towards the surface (Figure 6–34). Once on the surface, the gas will begin dispersion in the air. Gas does not dissolve in sea water. When mixed with air, gas forms a mixture that is flammable in certain gas concentrations. The lower explosive limit (LEL) of gas is approximately 4%. In concentrations below this the gas cloud will not be flammable. In this risk assessment the gas cloud is, in accordance with standard risk assessment practice, regarded as flammable in concentrations half of the LEL, which for natural gas means at 2%. *(Ramboll 2014b)*

1 IMO = International Maritime Organization

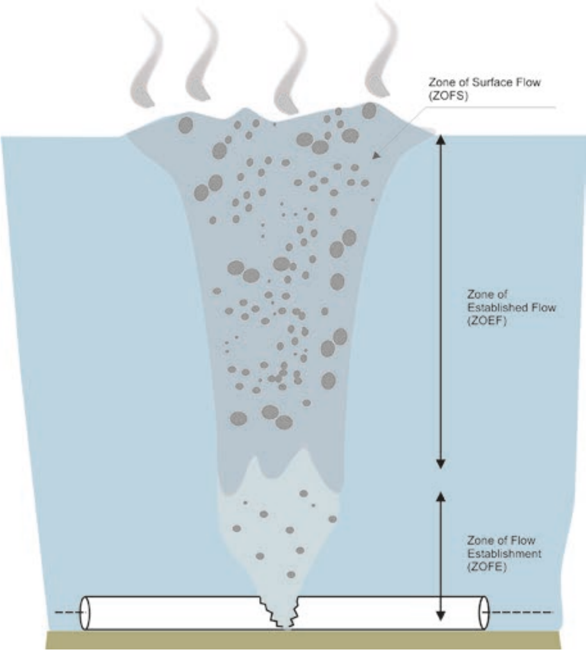


Figure 6-34. Release of gas from a damaged offshore pipeline *(Ramboll 2014b)*.

Figure 6-35 presents the dispersion of gas that has reached the surface in the air due to wind. The upper explosive limit (UEL) of gas, above which gas is not flammable, is shown in red in the figure. The area shown in yellow indicates the lower explosive limit (LEL), i.e. 4%, and the area shown in white indicates one-half of the LEL, i.e. gas concentration at 2%. Although a cloud of gas cannot in principle be ignited at concentrations below the LEL or above the UEL, in this risk assessment the entire gas cloud is assumed to be flammable when calculating the distance of the safety zone *(Ramboll 2014b)*.

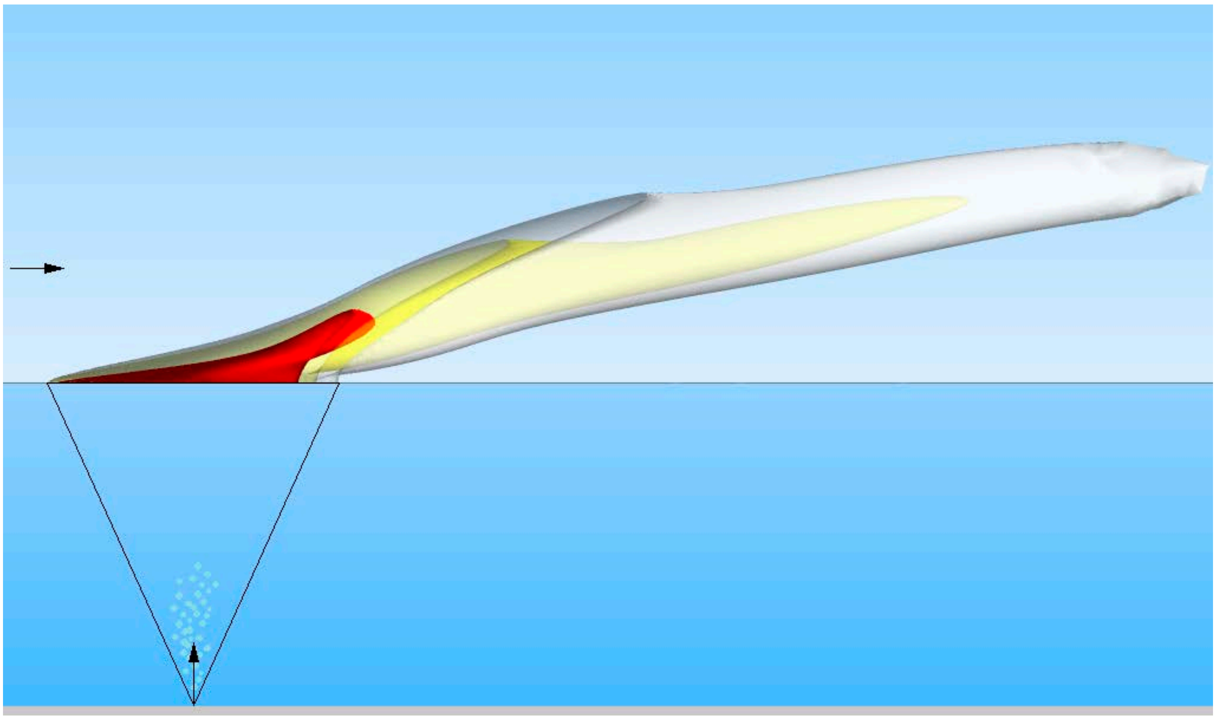


Figure 6-35. Release of gas from a damaged offshore pipeline (*Ramboll 2014b*).

In the risk assessment the distance of the hazardous area was calculated at four different wind speeds and for four different sizes of gas leak. The extent of the hazardous gas cloud is shown in the table below (Table 6-49) *(Ramboll 2014b)*. The extent of the hazardous gas cloud depends on the size of the leak and wind speed.

With small leaks the hazardous area is at its shortest some tens of meters, while in the unlikely event of pipeline rupture the hazardous area will in unfavorable weather conditions extend to a distance exceeding 700 m.

Table 6-49. Extent of hazardous gas cloud *(Ramboll 2014b)*.

Leak size	Wind speed, m/s	Distance of flammable area, m
Small	3	100
	8	60
	13	35
	18	20
Medium	3	170
	8	235
	13	215
	18	160
Large	3	270
	8	265
	13	350
	18	345
Rupture	3	725
	8	680
	13	530
	18	630

6.9.2.3 Risks of offshore gas pipeline leak to people

A gas leak into the sea and the resulting formation of a gas cloud is a highly unlikely event. Should this, however, happen, the gas cloud could lead into a flash fire of the gas cloud and damage to people caught in the fire *(Nord Stream 2009)*. Such a risk to individuals is assessed to be the highest among those working on board vessels sailing the Stockholm-Helsinki route. For example, M/S Mariella will cross the gas pipeline around 350 times a year *(Ramboll 2014b)*.

It is assumed in the quantitative risk assessment that 50% of the crew will be on the deck when the ship enters the gas cloud. The risk assessment was calculated for a ship in the Stockholm-Helsinki service that crosses the pipeline 350 times a year. It was assumed in the risk assessment that the period between the start of the gas leak and the issue of a warning about it is two hours. The leak size distribution used in the assessment is shown in the table below (Table 6-50). It was assumed in the risk assessment that the probability of a vessel igniting the gas cloud depends on the size of the cloud, not the size of the vessel. The assumed probability of a fire caused by a vessel is shown in the table below (Table 6-51). *(Ramboll 2014b)*

Table 6-50. Leak size distribution in the calculation *(Ramboll 2014b)*.

Leak size	Probability (%)
Small	74
Medium	16
Large	2
Rupture	8

Table 6-51. Estimated ignition probability. *(Ramboll 2014b).*

Leak size	Probability (%)
Small	0.25
Medium	0.25
Large	1.0
Rupture	1.0

The annual risk to individuals obtained is $9.08 * 10^{-7}$–$9.36 * 10^{-7}$ depending on the reason for pipeline damage. This risk corresponds to one accident in more than a million years. The result obtained is lower than $1 * 10^{-5}$ (one accident once in 100 000 years), which is a commonly used value for an acceptable risk to an individual.

The risk to groups was calculated for the most critical pipeline section, which is KPI 37–46. In the most critical 10 km section of the pipeline the risk to groups is at an acceptable level according to the calculations carried out in the risk assessment. *(Ramboll 2014b)*

6.9.2.4 Other risks posed by offshore gas pipeline leaks

Loss of water buoyancy

A possible pipeline leak may result in the loss of water buoyancy above the rupture. At worst a situation like this could cause instability in or the capsizing of a vessel above the rupture. The radius of the gas column on the surface of the sea would depend on the depth of the rupture, with the radius being the larger the deeper the gas leak takes place. For this reason the safety zone for vessels varies depending on the depth of the gas leak site. According to calculations carried out for other pipeline projects, only small vessels face the risk of sinking due to loss of buoyancy *(Nord Stream 2009)*.

Greenhouse gas emissions

In the highly unlikely but theoretically possible event of a gas pipeline rupture, the inlet valve to the damaged pipeline will be closed and as much gas as possible released from the pipeline via the outlet valve. Natural gas from the pipeline could be released into the air. In the event of a rupture, the amount of gas released could at a maximum be up to the volume of the entire pipeline, i.e. around 16,000 m^3. With the pipeline design pressure being 80 bar and the Baltic Sea bottom temperature around 4–6 °C, the volume of gas in the pipeline will correspond to a mass of 900 tonnes. Natural gas consists primarily of methane. The global warming potential of methane is 25 times greater than that of carbon dioxide. This means that 900 tonnes of natural gas released into the atmosphere corresponds to 22,000 tonnes of carbon dioxide equivalent *(Nord Stream 2009)*.

By comparison, Estonia's greenhouse gas emissions totaled an amount equivalent to 19.3 million tonnes of carbon dioxide *(Statistics Estonia 2014)*. Greenhouse gas emissions from a potential pipeline rupture correspond to less than 0.1% of Estonia's annual greenhouse gas emissions. The accelerating impact on global warming would be very small.

Water quality

Natural gas dissolves poorly into water, whereby the impacts of an offshore pipeline leak on water quality would be very low. The gas will rise to the surface and be released into the atmosphere. The dispersal of gas will depend on weather conditions (*Nord Stream 2009*).

There may be a brief temperature impact in the air as the expansion of gas results in a fall in temperature below the freezing point. Another possible phenomenon affecting water quality is the rise of bottom water. This may result in the mixing of bottom water with surface water, which may further affect salinity, temperature and oxygen conditions (*Nord Stream 2009*).

Impact on fish, marine mammals and birds

In the event of a gas leak from the pipeline, the fish, marine mammals and birds in the water column and in the gas cloud above the surface will die or escape. The affected area will be limited and so will be the duration of the impact.

6.9.2.5 Risks involved in the operation of the onshore gas pipeline

According to statistics, the biggest threat to natural gas pipeline safety is posed by unauthorized and unsupervised excavation work in the immediate vicinity of a natural gas pipeline. In this there is a risk of damage to pipeline structures resulting from excavation. Any gas leak in a pipeline will be detected immediately and the pipeline section will be isolated by closing the nearest shut-off valves and emptying the pipeline of gas. Once unpressurized, the pipeline can be safely repaired. Lighter than air, natural gas released due to a leak will rise.

6.9.3 Prevention and mitigation of adverse impacts

Ensuring safety is the basic requirement for natural gas use. Safety of usage can be promoted by issues such as careful planning, professional construction and assurance of work quality through inspections, expert and correct operation, and regular maintenance.

The legislation and regulations relating to natural gas provide the minimum level for safety that must be complied with in construction and operation.

Safety during construction

Construction will take place in compliance with existing legislation and regulations relating to construction. In addition, the safety and operational guidelines issued by the authorities, Gasum and the contractors will be taken into consideration. Particular attention will be paid to the safe movement of installation vessels. A safety zone will be established around vessels participating in construction, and the safe movement of other vessels will be ensured (see section 6.5.15.1). More detailed seabed surveys will be carried out before pipeline construction, with more detailed mapping of munitions and barrels also taking place in this context. These will be cleared from the gas pipeline corridor in a manner accepted by the authorities.

In the event of exceptional situations during construction, the procedure applied to the discontinuation of pipelaying due to poor weather conditions will be followed. Movement caused by weather or errors in the steering of the pipelaying vessel may cause the excessive buckling of the pipeline and result in a rupture in the pipeline wall. To prevent this, the pipelaying vessel may be equipped with a buckle detector that will set off an alarm if the pipeline inner diameter measurement becomes smaller. The buckle detector will be inserted in the pipeline, which is where it will monitor the bending point. If buckling is detected, the pipelaying vessel will reverse and any damaged connections will be removed. The same procedure will be followed if x-ray or ultrasound measurements reveal any non-acceptable weld circumferences. Delays in the schedule relating to situations described above will not result in any major problems in pipelaying.

If buckling leads into a wet buckle, i.e. water entering the pipeline, the situation will be more difficult. In such cases the pipeline must be quickly lowered onto the seabed or it may break under its own weight. The recovery of a pipeline filled with water may be difficult and result in further buckling, whereby the water will first have to be removed from the damaged pipeline section. This will involve measures including underwater installation work. The plan for underwater buckling is a follows:

- cutting off and removing the damaged pipe section;
- attaching water-pumping equipment to the landfall or vessel;
- removing sediment from the pipeline;
- installing the pipe recovery tool;
- emptying water from the pipeline using compressed air; and

- depressurizing the pipeline and recommencing pipelaying.

Safety during operation

To prevent gas pipeline damage, the following methods will be used to protect the offshore pipeline:
- pipeline trenching;
- rock dumping;
- increasing pipeline wall thickness or size.

A more detailed description of the methods is provided in section 3.4. Around 85% of the length of the offshore pipeline will be protected using some method.

Maintenance management of the gas pipeline will be carried out to ensure the pipeline is kept in good working order and will not pose a risk to the environment. Vessel traffic safety during operation is covered in more detail in section 6.5.15.1.1.

6.9.4 Summary of the significance of impacts and comparison of alternatives

Provided that more detailed seabed surveys will be conducted to map out any munitions and barrels and the recommended pipeline protection measures will be taken, the risk of a serious accident is very low.

There is no significant difference between the Finnish alternatives, ALT FIN1 and ALT FIN2, as regards safety. As regards Estonia, the risk assessment at this stage was only carried out for the ALT EST1 alternative, which is why no actual examination of the alternatives can take place at this stage.

6.10 Zero alternative

The zero alternative examined is the non-implementation of the Balticconnector project, i.e. a situation where the natural gas pipeline and the related functions will not be constructed. The environmental impacts of the zero alternative were assessed on the basis of the assumption that in the zero alternative the LNG terminal to be connected to the natural gas network and serving Finland and the Baltics will not be realized either.

The most significant uncertainties in the assessment of the environmental impacts of the zero alternative are related to natural gas consumption forecasts. Competitiveness between fuels and production forms depends on many issues, including the development of fuels, emission allowances and electricity prices as well as taxation. International and national energy and climate policies and national energy and climate strategies can also steer the fuel choices made by energy produces.

In the zero alternative the adverse environmental impacts of the Balticconnector natural gas pipeline during construction and operation will not be realized, but the project's positive impacts will not be achieved either.

If the Balticconnector project is implemented and the volume of natural gas consumption remains unchanged, the natural gas transmitted via the Balticconnector will not cause changes in emissions from energy production, industry or transport as these will replace the natural gas imported from Russia and Latvia via a natural gas pipeline of corresponding characteristics.

In the zero alternative natural gas is replaced by other fuels with higher combustion emissions and environmental impacts than natural gas. The overall consumption of other fuels is also higher than that of natural gas because with natural gas the efficiency of energy produced is on the whole higher than with other fuels.

The role of natural gas in Estonia in electricity production in particular is small, and the competitive setting between natural gas and other fuels is not as sensitive as in Finland.

The impact of the zero alternative would rather be political in nature and in conflict with the Estonian National Development Plan for the Energy Sector, according to which it is important to ensure independence of Russian gas and interconnections with the European gas network.

6.11 Cumulative impacts

The following provides an assessment of the potential cumulative impacts of the Balticconnector project with other known projects. The assessment only covers those projects that have been assessed to potentially have cumulative impacts with the Balticconnector project. For each project, only those cumulative impacts that are assessed to arise from the activities are mentioned.

Existing activities other than seabed cables and Nord Stream natural gas pipelines are not described or included in the cumulative impact assessments.

6.11.1 Gulf of Finland marine area

Other projects planned for the Gulf of Finland marine area and potentially causing cumulative impacts with the Balticconnector project comprise the Nord Stream extension project and the Ingå-Raseborg offshore wind farm (Figure 6-36). The Balticconnector natural gas pipeline route will also cross several existing electric and telecommunications cables as well as the two existing Nord Stream natural gas pipelines.

6.11.1.1 Nord Stream natural gas pipelines and extension project

The Nord Stream is a 1,224 km offshore natural gas pipeline system across the Baltic Sea from Portovaya, Russia, to Greifswalder Bodden, Germany. The route passes through the exclusive economic zones (EEZ) of Russia, Finland, Sweden, Denmark and Germany and through the territorial waters of Russia, Denmark and Germany. The gas pipeline was constructed and is operated by Nord Stream AG. Constructed in 2009–2012, the Nord Stream consists of two pipelines, each with an

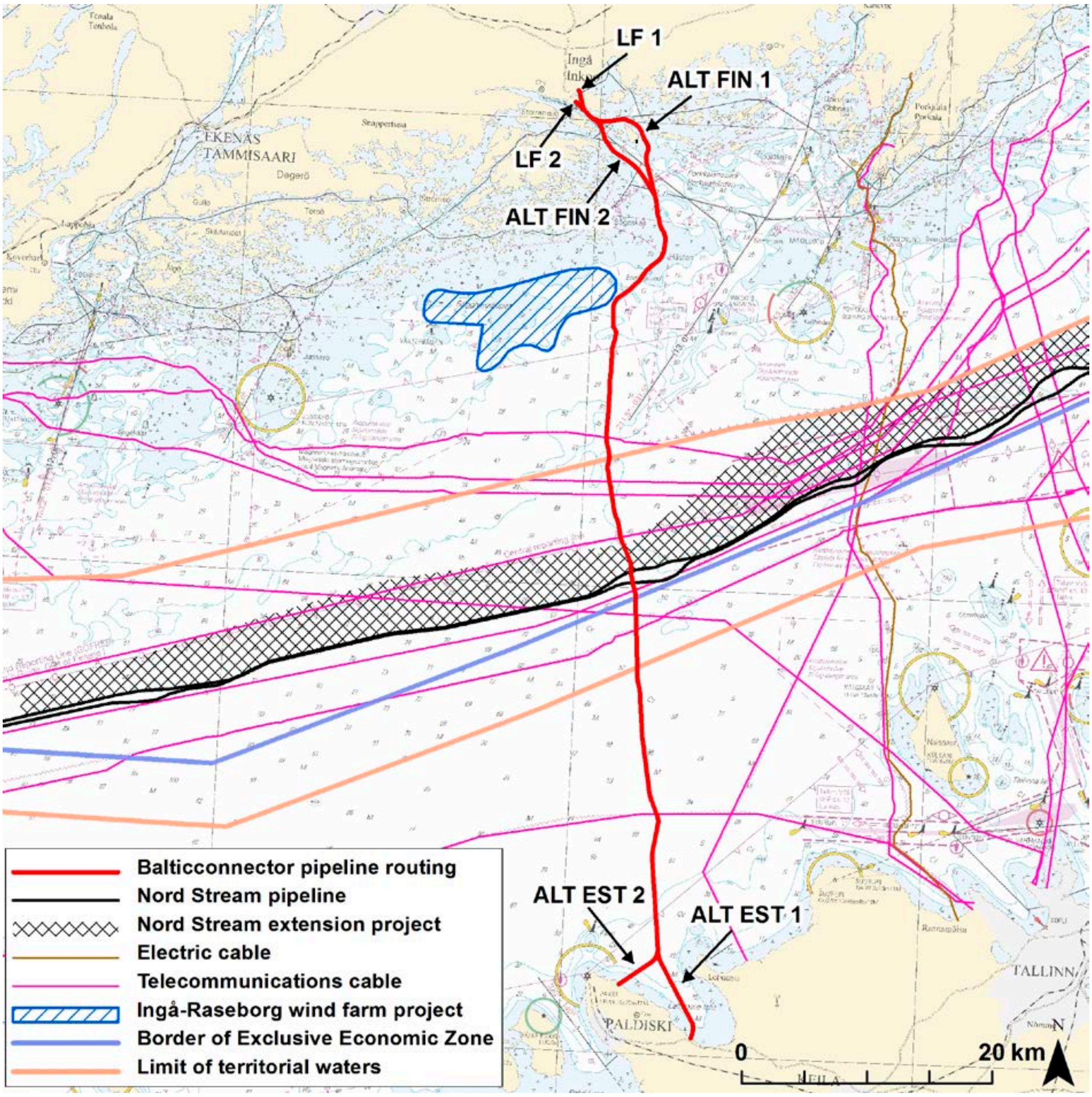


Figure 6-36. Projects planned for the Gulf of Finland marine area with potential cumulative impacts and the existing Nord Stream natural gas pipelines and electric and telecommunications cables.

annual throughput capacity of around 27.5 bcm. The first pipeline was opened in November 2011 and the second in October 2012. The Nord Stream pipelines will cross the Balticconnector pipeline.

The Nord Stream extension project comprises the construction of two offshore natural gas pipelines across the Baltic Sea from Russia to Germany. The routing alternatives extend from the Russian landfall via Finnish, Swedish and Danish waters to the German landfall. In the EEZ of Finland the route follows the routes of the existing Nord Stream gas pipelines 1 and 2. The total length of the routing alternatives is around 1,250 km.

The project's EIA procedure for Finland began in March 2013, and the coordinating authority issued its statement on the EIA program on July 4, 2013. According to the preliminary project schedule, pipeline construction will take place in 2016–2018. *(Ramboll 2013)*

If the Nord Stream extension project is implemented within the planned schedule (*Ramboll 2013*), the construction of natural gas pipelines under the project will take place during a period different from the construction of the Balticconnector natural gas pipeline. Therefore there will be no cumulative impacts during construction. When crossing the Nord Stream pipelines at the southern edge of the EEZ of Finland, pipeline protection measures will result in water turbidity during construction in areas close to the crossing point. During pipeline operation, the cumulative impact of the Balticconnector and Nord Stream pipelines may cause slight local changes in bottom flows as well as erosion or sediment accumulation in new areas. These impacts are not, however, anticipated to be significant. Correspondingly, the planned Nord Stream extension project will result in cumulative impacts with the Balticconnector to the same extent as is described above concerning the cumulative impacts of the Balticconnector and the current Nord Stream pipelines.

If the construction of the two natural gas pipeline projects will take place over the same period of time, the projects may have low negative cumulative impacts on birds and marine mammals. As the construction of the Nord Stream extension project will take place in offshore areas, its impacts will not extend significantly to the coastal area where the impacts of the Balticconnector on the natural environment during construction will be at their most significant.

If the construction of the Nord Stream extension project takes place before that of the Balticconnector project, vessel traffic during the construction of the latter may increase the accident risk of the Nord Stream project during operation to some extent. The risk posed by vessel traffic during construction to the Nord Stream extension project will, however, be low.

6.11.1.2 Ingå-Raseborg offshore wind farm

Suomen Merituuli Oy is planning an offshore wind farm west of the Balticconnector pipeline route off Ingå and Raseborg, Finland. The project covers offshore wind turbines, cabling required for the wind farm as well as power lines for connection to the national grid.

The wind farm will comprise a marine area that is approximately 5 * 20 km in size where around 60 wind turbines will be constructed. The turbines will have a hub height of around 100 m and capacity of 3–5 MW. The distance between the turbines will be around 700 m. The total capacity of the wind farm will be 180–300 MW.

The project's EIA procedure has been completed and the project is currently awaiting municipal land use planning. If completed according to the plans, the wind farm is due to be operational by 2020. According to a rough estimate, the wind farm can be constructed in 2–4 years. *(Suomen Merituuli 2014 & 2010)*

The wind farm project in the offshore area west of the Balticconnector pipeline route will involve large-scale dredging and deposition work which may, if coinciding with the construction of the natural gas pipeline, have considerable local cumulative impacts on water quality and the aquatic environment. The impacts on fish stocks and fishing will be similar to those of the impacts of the construction of the Balticconnector natural gas pipeline. As the projects will be located close to each other, simultaneous construction work would increase the adverse impacts on fish and fishing in the area. The cumulative impact would, however, overall be low as seabed intervention and gas pipeline installation will only take place for a short period of time in the area affected by the wind farm.

If the construction of these two projects takes place over the same period of time, the projects may have low negative cumulative impacts on birds and marine mammals.

The planned offshore wind farm and the Balticconnector project will also have low cumulative impacts arising from air emissions from vessels during construction. There will be a temporary increase in emissions into the air, but the impact will be short-term. The simultaneous construction of the projects would also increase the accident risk relating to vessels to some extent during the construction of the projects.

The wind farm will generate some above-water noise during operation within an area with a radius of around 1–2 km. The noise generated by the pipelaying vessel during pipeline construction will, however, be slightly different in nature than wind farm noise and be temporary. The largest noise emissions from the wind farm will take place during high wind speeds, which is when it is likely that pipelaying cannot take place. On the whole the change in noise situation would be small.

The wind farm planned for Ingå-Raseborg is not likely to have cumulative impacts related to land use with the Balticconnector project. If the wind farm and the power line connection required for it are included in the local master plan, the reservation for the Balticconnector natural gas pipeline must be taken into consideration in the plan.

6.11.1.3 Cables

There are many subsea telecommunications cables in the Gulf of Finland. According to preliminary plans, many of the identified telecommunications cables and a number of unidentified cables will cross the planned Balticconnector natural gas pipeline. These comprise both cables in operation as well as abandoned cables. The crossings will need to be agreed upon with the cable owners. Unidentified items such as cables detected in studies conducted during the Balticconnector project will be examined in the detailed design phase of the project. There are currently two known cable construction projects being planned that would intersect with the Balticconnect offshore pipeline. The Sea Liaon submarine cable system planned by C-Lion1 Ltd is a subsea fiber optic cable connection under the Baltic Sea. Connecting Finland and Germany and with a total marine cable length of aroun 1,150 km, the cable system would intersect with the Balticconnector pipeline in Finland's Exclusive Economic Zone south of Ingå. Construction is planned to begin in 2015. The other possible intersecting project is the Baltic Sea Optical Expressway marine cable system of the Swedish company Eastern Light from Rostock to Finland. There are no details available concerning the schedule of the project. The technical construction method description for infrastructure crossings is presented in section 3.4.2.

When crossing cables that are in operation, the measures to protect the cable and the Balticconnector pipeline will cause turbidity of water during construction work in the area close to the crossing point. The impacts are not, however, anticipated to be significant.

Any future telecommunications and electric cables as well as fairway projects may have cumulative impacts with the Balticconnector project. It is, however, difficult to assess the cumulative impacts in advance. In general terms the cumulative impacts with other seabed cables will be low and mainly relate to increased local bottom flow changes.

6.11.2 Paldiski area

Projects planned in Paldiski and potentially causing cumulative impacts with the Balticconnector project are the Paldiski LNG terminal, compressor station in Kersalu and planned category D natural gas pipeline from Kiili to Paldiski (Figure 6-37). It should be noted that natural gas pipeline from ALT EST 2 until the compressor station in Kersalu was not a subject of the current EIA. Despite this, it has probably a significant environmental impact since its route runs through Pakri Peninsula for approximately 8.5 km and should be considered as an essential section of ALT EST 2.

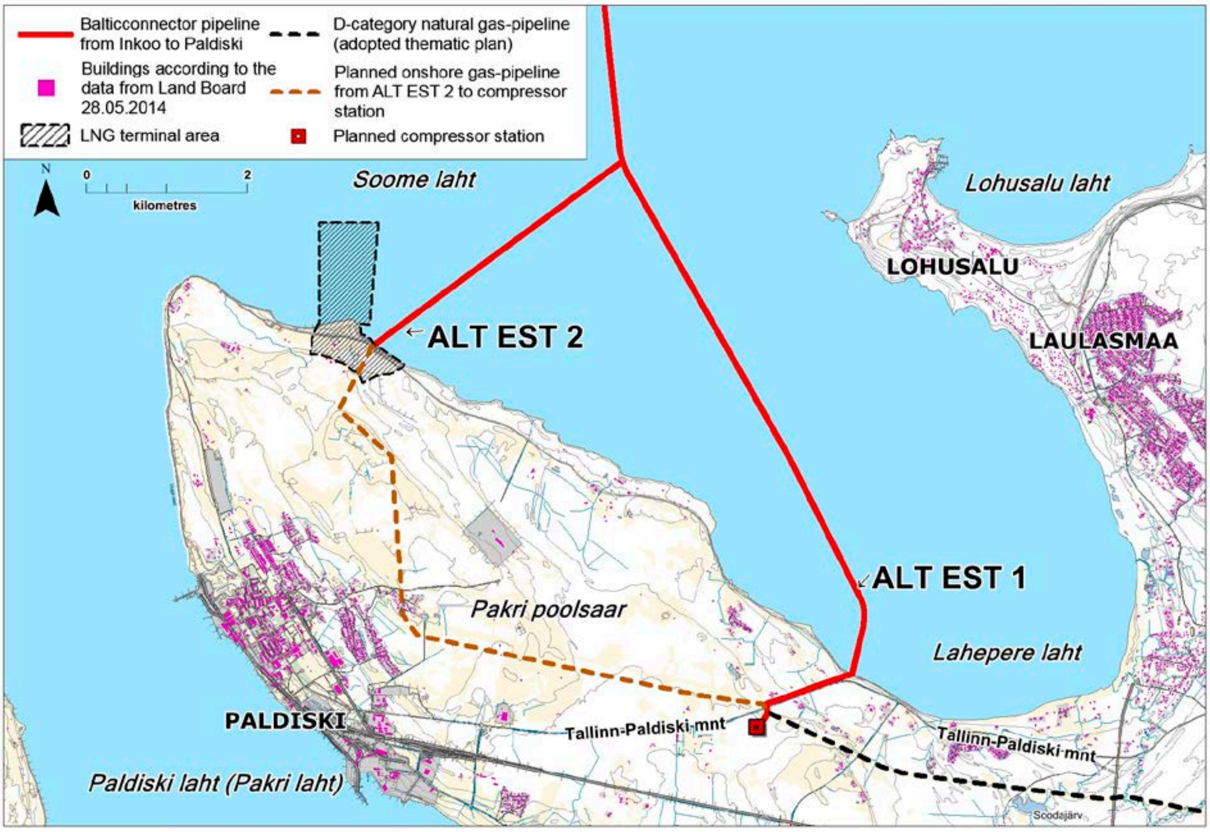


Figure 6-37. Cumulative impacts of the Estonian area in Paldiski

6.11.2.1 Planned LNG terminal in Paldiski

The thematic plan for the Paldiski LNG terminal at Pakri Peninsula was developed from 2010 to 2012, and adopted by decision no 5 of Paldiski City Council on September 27, 2012. The planned area is located on the north-eastern shore of the Pakri Peninsula on the shore of Lahepere Bay in the area between the sea and Kadaka tee. The thematic plan was necessary to determine the location of the object with significant spatial impacts, which the LNG terminal is considered to be. The developer of the LNG terminal is Balti Gaas OÜ.

The area of the thematic plan is 230 ha. The terminal will be built for:

- receiving the liquefied natural gas (LNG) from tankers;
- storage and distribution of LNG;
- vaporization of LNG.

According to the plan, in the first construction phase of the LNG terminal, the annual turnover will be 3 million tonnes.

According to the thematic plan titled "Location of the category D natural gas pipeline", the thematic plan of the Paldiski LNG terminal also addresses the connection pipeline from the LNG terminal to the planned compressor station in Kersalu. In cooperation with Paldiski City Government, AS Eesti Gaas and OÜ Balti Gaas, the idea of transferring the point of landfall of the category D pipeline and compressor station to the land of the Paldiski LNG terminal is being considered (ALT EST 2). The route of the planned pipelines runs mainly parallel to the existing high voltage power lines and planned wind park area (at the end of LNG terminal). A medium pressure gas pipeline is planned for supplying natural gas to the City of Paldiski. If gas consumption increases in the future, the expansion of the terminal complex is possible. The maximum radius of the danger zone of the terminal is 750 m.

Based on the SEA of the thematic plan of the LNG terminal – as a standalone site on the land adjacent to the terminal, an option is provided for the construction of a compressor station for the Balticconnector natural gas pipeline (see Figure 5-76). The compressor station is planned to allow reverse flow. If needed, it will enable natural gas to flow in both directions, from Estonia to Finland or vice versa from Finland to the Baltic States.

SEA report of Paldiski LNG terminal thematic plan (*OÜ E-Konsult 2012*) page 25: *The Paldiski LNG terminal thematic plan enables the option to change the location of the compressor station by placing it next to the planned LNG terminal. The LNG terminal and the gas compressor station in the previously planned location must anyway be connected via a high pressure gas pipeline.*

The LNG onshore detailed plan (43 ha) was adopted by the decision no 21 of Paldiski City Council on May 22, 2014. The objective of the detailed plan is to change the boundaries of registered immovable properties, more detailed definition of the building rights for the erection of the LNG terminal and its ancillary buildings, the solution of technical communications and traffic management, the definition of environmental criteria and clearances in the onshore part of the city of Paldiski. The detailed plan is based on the Paldiski LNG terminal thematic plan and the detailed plan does not provide for the amendment of the thematic plan (comprehensive plan). According to page 4 of the explanatory letter of the LNG onshore detailed plan: *The LNG detailed plan will not resolve the issues related to the construction of the natural gas pipeline called Balticconnector (together with its associated facilities). Therefore, the exact location of the Balticconnector natural gas pipeline and its associated buildings is not currently known. The building rights granted to plots related to the detailed plan have been granted in consideration of the possibility that the Balticconnector natural gas pipeline (together with its associated facilities, including the compressor station and Balticconnector's point of landfall) may in the future be constructed on the land of the LNG terminal. If an agreement is reached regarding the construction of these facilities on the land of the Paldiski LNG terminal, their location will be resolved with a design of the relevant site within the boundaries of the LNG terminal land.* Landfall ALT EST 2 in Pakrineeme is located in the area of the adopted detailed plan of Paldiski LNG terminal, in the property known as Male. According to the adopted detailed plan, the maximum size of the building right area is 12,000 m² in Male property. The LNG terminal detailed plan provides that all the planned buildings, civil engineering work and infrastructure must be located in the determined building area.

The drafting of the detailed plan of the quay (0.9 ha) of the Paldiski LNG terminal was commenced on October 1, 2012.

An EIA process for the permit for the special use of water (construction of quay) was initiated on January 23, 2013. The developer is Pakrineeme Sadama OÜ and the EIA expert is OÜ Hendrikson & Ko. According to the published EIA program, the quay will be approximately 1 km long (from coast). One leveler will be 320 m long at a depth of 14 m and another 625–800 m from the shoreline and approximately 175 m long at a depth of 9.5 m. The EIA program was approved by the Environmental Board on June 3, 2013.

The construction stages of the Balticconnector project and the LNG terminal will not be dependent on each other, and their cumulative impacts will depend on implementation schedules. On the basis of the detailed land use plans for the LNG terminal, the construction of the quay will take place in the summer while tank construction will take place in the winter. No excavation or deepening work will take place for quay construction.

The significance of the cumulative impacts will be affected by the timing of the work; if the marine works are carried out simultaneously, the level and duration of the load of suspended solids in the Lahepere Bay will increase. The cumulative impact will be particularly apparent if the ALT EST 2 alternative is implemented. Correspondingly, if implemented in different years, the significant adverse impact in the area will be repeated.

The LNG terminal project will change the natural environment of the Pakri Peninsula and reduce its natural value to an extent that is considerably larger than the impact of the Balticconnector project. The level or duration of noise and turbidity during construction will increase if both projects (LNG terminal and ALT EST 2) are implemented simultaneously.

The LNG project will not involve the dredging of the seabed as the quay will be constructed on piles. If seabed intervention, pipelaying or pipeline protection work takes place simultaneously with quay pile construction, these may have cumulative underwater noise impacts. The level of impacts will depend on the timing and overall duration of the work, but some adverse cumulative impacts may occur on nearby protected areas.

If the LNG terminal is constructed on the Pakri Peninsula, the nature of the environment, its status in the overall landscape and views towards the area will change significantly. If the terminal is constructed, the natural gas pipeline will become part of a large-scale complex of industrial facilities.

In the unlikely but possible event of an accident involving the Balticconnector project, any gas leaks may be flammable and/or toxic and hazardous to humans. The possible location of the LNG terminal is in the vicinity of the ALT EST 2 alternative of the Balticconnector project. Any safety risks posed by the LNG terminal must be taken into consideration in the more detailed design of the Balticconnector project. The design of the LNG terminal and the ALT EST 2 alternative must be harmonized to ensure good safety in the area.

Simultaneous construction of LNG terminal and Balticconnector natural gas pipeline will cause an increase in noise level. Cumulative impact is remarkably higher in the ALT EST 2 case. Cumulative noise impact is limited within construction period.

The LNG terminal and the construction of the Balticconnector project may have low cumulative impacts on air quality during pipeline construction.

Cumulative impacts on on Pakri habitats directive site see 6.7.4.

6.11.2.2 Compressor station in Kersalu

Compressor station in Kersalu is one part of Balticconnector development project. The thematic plan titled "Location of the category D natural gas pipeline" in the territory of the city of Paldiski defines the location of the compressor station and the point of landfall of the gas pipeline in Kersalu (referred to in this EIA report as ALT EST 1). Based on the thematic plan detail plan titled "Detailed plan of the category D natural gas pipeline compressor station" was compiled and adopted by the decision no 333 of Paldiski City Council on October 20, 2014. The developer of the compressor station is AS EG Võrguteenus. Compiling Preliminary design documentation of location of the category D natural gas pipeline is in process.

A cumulative impact of the Balticconnector and the compressor station may occur during construction. Impacts during construction may mainly comprise noise and vibration if pipeline trench is excavated simultaneously excavation work for the compressor station is carried out. The cumulative noise and vibration impact will, however, be low, with the periodic scheduling of construction work available as a mitigation measure.

The construction of the compressor station and the Balticconnector project may have low cumulative impacts on air quality during pipeline construction.

There will be no cumulative impacts during operation.

6.11.2.3 Paldiski–Kiili category D natural gas pipeline

The onshore route of the planned natural gas pipeline from Kiili to Paldiski in Estonia concerns six municipalities: Kiili, Saku, Saue and Keila rural municipalities, towns of Keila and Paldiski. Balticconnector will be connected via the compressor station to this natural gas pipeline and in that context should be looked as one section of the entire project.

In Kiili municipality, the detailed plan related to the natural gas pipeline and its facilities was adopted by the decision No. 22 of the Kiili Municipal Council on April 9, 2009.

In Saku municipality, the route of the planned natural gas pipeline has been determined by a comprehensive plan (adopted by the decision No. 22 of the Saku Municipal Council on April 9, 2009).

In order to determine (specify) the location of the natural gas pipeline route in the territories of Saue and Keila municipalities and the cities of Keila and Paldiski, thematic plans of the comprehensive plan were developed titled "Location of the category D natural gas pipeline" which was initiated in 2006. As of today, the relevant thematic plans have been adopted by these municipalities, including the completion of strategic environmental impact assessment (SEA) (Table 6–52).

Table 6–52. Date of adoption of thematic plan and approval of SEA report in four municipalities.

Municipality	Date of adoption of thematic plan	Date of approval of SEA report
Saue municipality	20.12.2012	10.12.2012
Keila city	18.12.2012	10.12.2012
Keila municipality	27.3.2013	10.12.2012
Paldiski city	22.12.2011	4.9.2007

The thematic plan titled "Location of the category D natural gas pipeline" in the territory of the city of Paldiski defines the location of the compressor station (including the consideration of alternative locations) and the point of landfall of the natural gas pipeline in Kersalu (referred to in this EIA report as ALT EST 1). The thematic plan has been established with the following condition: *If the thematic plan of the planned Paldiski LNG terminal, upon its adoption, provides for moving the location where the pipeline enters the sea and the* *compressor station to the area of the LNG terminal, it will be grounds for changing this thematic plan in the manner that the compressor station and the location where the pipeline enters the sea are located in a site provided for by the LNG terminal project. However, the relevant EIA and seabed surveys must be conducted when planning the point of landfall, therefore the currently planned site in Kersalu may remain as an alternative. If the construction of the Paldiski LNG terminal is unsuccessful, the solution provided for by the current thematic plan will remain in effect (the location of the compressor station and point of landfall in Kersalu).*

Onshore pipeline projects (from compressor station up to Kiili natural gas network and the compressor station in Kersalu) will be implemented by Estonian developers and are not within the scope of the Balticconnector project that is currently being evaluated. The current status of these individually implemented projects/developments is as follows:

- A detailed plan of the compressor station (in Kersalu) was initiated on May 23, 2012 by the City Government of Paldiski under Order no 159. The developer is AS EG Võrguteenus. The detailed plan was approved by order number 333 of the City Government of Paldiski on October 20, 2014;
- Keila city government issued a building permit for building Category D pipeline on its administrative territory on May 31, 2013;
- Kiili municipal government issued a building permit for building Category D pipeline on its administrative territory on January 8, 2013;
- Saue municipal government issued a building permit for building Category D pipeline on its administrative territory on February 2, 2015.

Keila, Saue and Saku municipal governments have issued design criteria for detail design of Category D pipelines in their administrative territory.

A cumulative impact of the Balticconnector and the Paldiski–Kiili gas pipeline may occur during construction. The impacts during construction may mainly involve noise and vibrations during pipeline trench excavation. The cumulative noise and vibration impact will, however, be low, with the periodic scheduling of construction work available as a mitigation measure.

The planned natural gas pipeline and the Balticconnector project will not have significant air emission impacts.

There will be no cumulative impacts during operation.

6.12 Transboundary impacts across the borders of Estonia

The Balticconnector project is not estimated to cause significant transboundary impacts across the borders of Estonia. The pipeline will extend across western Gulf of Finland to Finland, whereby construction work in Estonian waters may result in low impacts in the economic zone of Finland and very low impact if at all in Finland's territorial waters. No impacts are estimated to occur on other Baltic Sea Region states.

Seabed intervention will take place almost throughout the pipeline route, whereby there will be impacts in Finnish as well as Estonian territorial waters. Construction work closer to the border of Exclusive Economic Zone may result in transboundary impacts on both sides.

The deterioration of water quality arising from seabed interventions relating to the construction of the gas pipeline will be restricted in terms of area and duration. According to preliminary plans, the type of construction carried out near the limit of territorial waters, north of KP 53, will either be dredging or ploughing.

Marine works carried out in Estonian waters may cause some turbidity carried across the state borders. The contaminant contents found in sediment samples obtained from the Balticconnector pipeline route were, however, low, and their distribution with solids during construction is not likely to pose a risk to the marine environment. Construction works carried out in Estonian Exclusive Economic Zone and impacts due the turbidity will not cause significant harmful impact to the Finnish Exclusive Economic Zone nor territorial waters.

Construction work relating to the Nord Stream gas pipeline project (*2009–2012*) as well as the technical characteristics of the gas pipeline and the methods relating to its construction and testing will essentially be similar to those in the Balticconnector project, especially in offshore areas close to the limits of territorial waters. In the Nord Stream gas pipeline project, environmental impacts during construction were monitored, with the results obtained providing measured empirical data, particularly concerning offshore areas. It was stated on the basis of the monitoring that sediment displacement due to construction work was low. No significant changes in concentrations of heavy metals, organic compounds or nutrients were detected in sediments. The changes in sediment chemistry were better explained by natural changes in concentration than by pipeline construction work. *(Nord Stream 2010, 2013)*

In general the impacts of Nord Stream construction on water quality were temporary, local and low. The diameter and capacity of the Nord Stream pipeline are, however, around twice those of the planned Balticconnector pipeline, whereby as a general rule the impacts relating to trench size and water flows in the nearby area will be slightly smaller in this project. Based on these observations it can be assessed that the Balticconnector project will not have significant transboundary impacts regardless of whether construction work takes place in the Finnish or Estonian waters. Any low impacts taking place will be short-term and local.

Following the pressure test, the seawater used to flood the pipeline will be filtered and treated with oxygen scavengers and/or biocides. Flooding can also be carried out using clean water without any additives.

When using oxygen scavengers or biocides, the water removed is led into a basin for the settlement of solids and any impurities in them. Following the settlement process, the water is pumped into a marine area where mixing will take place rapidly. If the flooding is carried out using filtered water, there is no need for settling and the water can be led in a controlled manner into the sea. If the flooding water of the Balticconnector pipeline is pumped into the marine area in Finland, possible adverse impacts to the water quality can be considered as transboundary impacts. However, due to the small volume of water and the short duration of discharge, the impact of flooding water can be assessed as low on the basis of the experiences gained from the Nord Stream project.

Underwater blasting, however, will cause brief and high levels of sound pressure transported over distances of tens of kilometers. Underwater blasting will take place in Estonian as well as Finnish territorial waters. The number of blasting sites will, however, be smaller on the Estonian side. The closest excavation point where blasting could be performed is located approximately 2.5 km from the Finnish border of the Exclusive Economic Zone and approximately 15 km from the limit of Finnish territorial waters. As the distance from the blasting site increases, the impacts are reduced as the intensity of the sound decreases.

Deep-bottom zoobenthos will be destroyed almost all the way underneath the pipeline, but on the whole the natural gas pipeline is not estimated to pose a major risk to offshore soft-bottom benthic communities, which due to poor oxygen situation are quite non-diverse and have good recovery potential.

Gas pipeline project activities taking place within the borders of Estonia during construction or operation are not estimated to have significant transboundary impacts on flora, birds or marine mammals. Underwater noise from seabed excavation and possible blasting may be carried to the Finnish territorial waters, whereby seals or harbour porpoises in the area may hear sounds caused by blasts. Due to the large distance, however, there will not be significant noise impacts on the behavior of marine mammals.

The nearest Natura 2000 sites to the limit of Estonian territorial waters are the Kallbådan islets and waters and the Natura site of the Ingå archipelago, both at a distance of approximately 30 km. Balticconnector project activities on the Estonian side will not result in impacts on the protection principles of the Natura sites.

As regards above-water noise, noise propagation will be in the same range as the modeling results for onshore noise for the ALT EST 1 and ALT EST 2 routing alternatives, with the average sound level of 45 dB(A) propagating over a day to an estimated 500 m from the pipelaying vessel. All in all the above-water noise impacts will be low and short-term, and no significant transboundary impacts across the Estonian borders are estimated to occur during project construction or operation.

Seabed intervention will mainly result in momentary local impacts on other vessel traffic with a maximum duration of few days for each area. In the offshore areas between Finland and Estonia where the pipeline will cross busy fairways the safety zone will result in impacts on other vessel traffic as the diversion of the safety zone of the installation vessel will required. This is not estimated to have a significant impact on the safety of vessel traffic considering the existing navigation and traffic control measures.

Emissions from the vessels participating in pipelaying will have an impact on air quality in the Finnish territory when the vessels are close to the Finnish territory. The impacts will be very low and remain close to the route taken by the vessels.

The transboundary impacts of the project on people and society will be low. There will be a temporary increase in technological and economic activity in Estonia and well as Finland during construction. During operation, there will be an emphasis in transboundary impacts on the territory of the two states on the role of the gas pipeline as an energy transport channel reducing dependency on Russian gas supply. The Balticconnector pipeline will not cause restrictions on bottom trawling, whereby there will be no impact on those who work in fisheries.

In a possible worst-case scenario accident in the Estonian exclusive economic zone (gas pipeline rupture), the size of the dangerous flammable gas cloud is slightly over 700 m, when the impact will reach also Finnish exclusive economic zone. The extent of the hazardous gas cloud depends on the size of the leak and wind speed. A gas leak into the sea and the resulting formation of a gas cloud is a highly unlikely event. Should this, however, happen, the gas cloud could lead into a flash fire of the gas cloud and damage to ship passangers caught in the fire in Finnish waters. According to risk assessment made for Balticconnector project, this risk corresponds to one accident in more than a million years.

During operation following pipeline installation, there may the possible impact of changes in flows. If occurring, flow changes may cause erosion in new areas, but their extent and impacts will be small. Pipeline anodes may also release very small quantities of metals (Zn, Al) in the immediate vicinity of the pipeline.

6.13 Use of natural resources and the compliance of construction of the natural gas pipeline with the principles of sustainable development

The action plan for energy efficiency of the European Union was adopted in April 2000 to reduce the consumption of energy, protect the environment, ensure security of supply and a sustainable energy policy by improving energy efficiency. Energy efficiency means development of a conduct, working method or production technology that is of lower energy intensity.

An extensive integration of the energy networks of Estonia and the Baltic Sea region is important in terms of security of supply and energy security, as well as from the standpoint of supplying energy to the residents of Estonia at the lowest possible price.

The natural gas pipeline route (Ingå-Paldiski) selection was based on the featuring the shortest offshore section and the fact that the pipeline and the compressor station can in both countries be coordinated with the land use in the area. Several factors were taken into consideration in the determination of the current route of the offshore natural gas pipeline, including route length, existing natural gas network, local areas, regulations and guidelines concerning land use planning, fairways, military areas, anchoring areas, geophysical characteristics, bathymetry, geotechnical and geophysical surveys along the offshore pipeline route.

The Balticconnector pipeline has one location track across of the Gulf of Finland. Two possible alternative points of landfall have been assessed on the Pakri Peninsula: Kersalu (ALT EST 1) and Pakrineeme (ALT EST 2)

The pipeline's length in the sea will be approximately 81 km and on the mainland 1.3 km in case of ALT EST 1. The sea section of ALT EST 2 is approx. 78 km and additional mainland section to Kersalu 8.5 km long.

The pipeline will be constructed from carbon steel line pipes with a diameter of 508 mm and thickness of 12.7 mm and will be coated over their entire length with concrete coating. The concrete will comprise a mix of cement suitable for marine use, water and aggregate such as crushed rock or gravel as well as iron ore aggregate added to the mixture.

During the construction of the Balticconnector excavation is planned to level the seabed. Subsea rock installation will be used on the seabed during preparation (pre-lay, post-lay, cover) to level the seabed and protect the pipeline.

The table below summarizes the main construction work and materials required for the structural options presented in the pre-FEED report.

Table 6-53 Pipeline main construction work and material.

Pipeline construction, material	Unit	Estonian part	Total
Trenching length	km	6.4	34.4
Excavation to level the seabed	m^3	86000	171000
Rock pre-lay, post-lay and cover	m^3	353000	985000
Line pipes (carbon steel D505x12,7 mm)	km	36.4	81.4
Concrete coating	m^3		9544

The preferred alternative ALT EST 1 is shorter by a total of 4 km and the demand of pipe material is lower when compared with ALT EST 2. The natural gas pipeline construction amounts and materials are the estimated required quantities and will be optimized in the detailed design phase. The planned activities can be mitigated to minimize significant impacts to the environment during the construction period.

7 COMPARISON BETWEEN ALTERNATIVES

7.1 Principles applied in the comparison between alternatives

The characteristics and factors essential from the environmental impact perspective were assessed on the basis of preliminary design data. A survey of the current state of the environment and factors affecting it was conducted for the environmental impact assessment on the basis of existing data and studies conducted for the EIA procedure.

The project's environmental impacts were examined by comparing the changes brought about by the implementation of the project with the current situation. Efforts were made to pay particular attention to the clarification and description of impacts found important on the basis of feedback received from various stakeholders during the EIA procedure.

The significance of environmental impacts was assessed on the basis of the cumulative impact of the sensitivity of the current state of the area or site affected and the magnitude of change caused by the project. Also taken into consideration in the assessment of the significance of the environmental impacts were the monitoring group opinions on the quality and sufficiency of the assessment work received during the drafting period. The significance of the impacts was examined on the basis of the assessment matrix developed in the IMPERIA project (see section 6.4.3).

Factors essential to the assessment of the significance of impacts are:

- geographical extent of the impact;
- duration of the impact;
- receptor of the impact and its sensitivity to changes;
- the significance of the receptor;
- reversibility and permanence of the impact;
- intensity of the impact and the magnitude of the change caused;
- fears and uncertainties relating to the impact;
- differing opinions on the significance of the impacts.

7.2 Comparison between alternatives

The impacts of the assessed alternatives and their significance are presented in the tables below (Table 7-1 and Table 7-2). The table provides a uniform presentation of the key environmental impacts arising from the alternatives. The feasibility of the alternatives from the environmental perspective is assessed at the end of the section.

Table 7-1. Assessment scale employed in the assessment of significance.

Significance of impacts	Very high ++++
	High +++
	Moderate ++
	Low +
	No impact
	Low -
	Moderate --
	High ---
	Very high ----

Table 7-2. The most significant environmental impacts of the implementation alternatives of the Balticconnector project assessed (ALT EST 1 and ALT EST 2) and their significance in comparison with the current situation and the non-implementation of the project (zero alternative).

Environmental impacts	Zero alternative	ALT EST 1	ALT EST 2
Seabed	No impacts.	The natural gas pipeline will cause a change on the seabed along the pipeline route. The surface area of the horizontally impacted region and the thickness of the removed sediments express the magnitude of the change. Changes resulting from the project will be insignificant in the offshore part. The project will cause little change to the status of the region. The impact will be directly evident in the area where the pipeline is covered or sediment is removed or where the sediment raised into the water column later settles. Sediments removed from the trench will not exceed the limit value and the amount/load of emission will be low. Operation and maintenance will have low or will have no impact on the seabed.	
		There will be no impact on the development of the shores of Lahepere Bay as a whole, especially on the shore processes within the sandy beach during the construction as well as during operating and maintenance.	
Water quality	No impacts.	Although the results of resuspended particles spread modeling indicated that floating material can spread quite far towards both shores of the bay, most of the material would settle in the immediate vicinity of the work area. A certain amount of sediment can be transported and settle outside Lahepere Bay towards the open sea from the tip of Ihasalu peninsula only for ALT EST 2 in case of strong NW winds. The impact of harmful substances raised into the water column during the construction of Balticconnector will be smaller than was seen during construction of the Nord Stream pipeline. However, considering the planned procedures for preparing the route and for protecting it in areas with high vessel traffic and in coastal waters, the construction work will definitely have a certain impact on the ecosystem of the gulf. The maximum amount of phosphorus released as a result of the work would be up to 1.2% of the phosphorus loads from the mainland and phosphorus released from the sediment in anoxic conditions. Increased concentration of toxic substances in the water column is unlikely.	
Benthic fauna and aquatic flora	No impacts.	Considering the width of the seabed included in the construction work (up to 50 m with the trench) and the resuspended particles generated due to sediment digging, with its settling process in a range of 700 m, the impact on benthic fauna will negatively moderate and reversible. Benthic fauna will be restored within 1 to 5 years. The impact on benthic fauna during pipeline operation will be insignificant.	
Fish and fisheries	No impacts.	The impact of noise on the fish fauna generated due to construction work can be assessed as moderate to low, depending on the amount of blasting. On an individual level the impact can be irreversible if a fish is injured or killed. However, on the population level the impact will bereversible and end with the completion of construction work. Considering the fact that fish fauna near the pipeline will be small during the construction work, the impact of changes in the food basis on the fish fauna is assessed as insignificant. The impact on fishing deriving from fish fauna during the construction period is assessed as moderate and reversible. The original natural conditions regarding fish fauna will presumably be restored once the project activities are completed.	
		The impact of pipeline maintenance on the fish fauna of Lahepere Bay is assessed as insignificant	

<table>
<tr><th>Environmental impacts</th><th>Zero alternative</th><th>ALT EST 1</th><th>ALT EST 2</th></tr>
<tr><td>Conservation areas</td><td>No impacts from construction on plant or animal species or conservation areas in the Paldiski area. Negative impacts on some species and habitats due to air emissions and climate change.</td><td>A total of 120 m of the seaside section of the route of ALT EST 1 would be located in the planned Pakri nature conservation area.

The impact will be reversible if mitigation measures are applied.</td><td>The ALT EST 2 landfall will be located in the Pakri nature conservation area.

The impact will apply to all protected habitats in the construction zone if the trees and plants will be cut along the pipeline corridor. Since the natural gas pipeline landfall is planned as a microtunnel passing underneath all these habitats, the habitats will remain untouched.

As the project area will affect plants in the middle part of the protected landscape in an area that currently has very low human impact and is not recoverable, the impact should be considered as high negative in terms of its significance. Although the magnitude of the change can be considered as moderate, all habitats in the area are very valuable and vulnerable, and therefore the significance cannot be less than high.</td></tr>
<tr><td>Flora</td><td>No impacts.</td><td>Two habitats of the small pasque flower (I) located at the Kersalu route will be completely destroyed and a smaller habitat of the sea pink (Armeria maritima subsp. Elongata) will be directly within the construction area of the pipeline. The impact is reversible if the mitigation measures will take effect after construction.</td><td>There are plant habitats at the landfall site and 50 m inland that are mostly assessed as valuable Natura 2000 habitat types (sandstone and slate banks, bank forests)</td></tr>
<tr><td rowspan="2">Bird fauna</td><td rowspan="2">No impacts.</td><td>In relation to destruction of nesting locations, the most sensitive species at the ALT EST 1 route are the Red-breasted Flycatcher and other small forest birds. The impacts will be reversible if mitigation measures are applied.</td><td>It is assumed that six protected bird species are present in the area.</td></tr>
<tr><td colspan="2">The impact of noise and visual disturbance on marine birds will be direct, negative and intensive, but due to its short duration it is evaluated to be moderate. As the impact of construction work on the benthos and fish will be moderate and reversible, the indirect impact on the avifauna is considered to be minor and reversible</td></tr>
<tr><td rowspan="2">Other fauna</td><td rowspan="2">No impacts.</td><td>Change in the habitat will be reversible for forest species such as Formica, tree bumblebee and common carder bee if the mitigation measures take effect after construction.</td><td>Considering the construction method planned for Pakrineeme and its limited impact (microtunnel), the impact on fauna will probably be limited.</td></tr>
<tr><td colspan="2">As Lahepere Bay is not known to be an important calving area for grey seals, the negative impact of noise from construction work to the species in Lahepere Bay and its nearest surroundings is considered to be low and temporary.</td></tr>
<tr><td rowspan="2">Soil, bedrock and groundwater</td><td rowspan="2">No impacts.</td><td colspan="2">The main impact on surface and groundwater will be related to construction activities. The impact will accrue due the water level depression on the pipeline route. The impact will be local, negative-low and recoverable after the construction period. There will be no impact during pipeline operation.</td></tr>
<tr><td>In the Kersalu landfall location, where the plan is for the route to make landfall in a trench, the impact on the soil in the land section of the affected area will be negatively high. The impact will be irreversible on the planned Pakri nature conservation area (bottom rock corresponding habitats) if mitigation measures are not applied (closed construction method).</td><td>The microtunnel option will cause minimum damage to the main feature in the Pakri landscape reserve, the Cambrian / Ordovician scarp of the Baltic Klint.</td></tr>
</table>

<table>
<tr><th>Environmental impacts</th><th>Zero alternative</th><th>ALT EST 1</th><th>ALT EST 2</th></tr>
<tr><td rowspan="2">Noise</td><td rowspan="2">No impacts.</td><td colspan="2">The highest risks of underwater noise are expected in the Pakri Natura 2000 site (Lahepere Bay) where sound pressure levels will be at their highest during construction (pipelaying and trenching). The near- and far-field effects of blasting of bedrock peaks at the pipeline route are major risks in the offshore area. The operational phase noise impact is considered to be virtually insignificant</td></tr>
<tr><td colspan="2">The daily guideline value for above-water and onshore noise impacts of 45 dB(A) (nature conservation areas, recreational areas) may be exceeded during construction in the construction area near the Natura site in the ALT EST 2 alternative. Some residential buildings will be within the noise zone in ALT EST 1. The calculations did not reveal any significant differences between the alternatives concerning adverse noise impacts.

Noise impacts during operation will be low if any.</td></tr>
<tr><td rowspan="2">Vibrations</td><td rowspan="2">No impacts.</td><td colspan="2">Vibrations during construction will mainly be caused by blasting explosions. Vibrations from underwater explosions may have a temporary impact on the residential comfort of the nearest residents. There will be no vibration impacts from the project during operation.</td></tr>
<tr><td>Excavation work relating to the ALT EST 1 landfall and onshore pipeline may result in vibration impacts in the local environment. The vibration impact from excavation will be short-term in nature. The nearest residential building is located around 62 m from the pipeline to be constructed. Excavation work may cause vibration impacts possibly resulting in temporary reductions in residential comfort.

No vibrations will arise from activities during pipeline operation.</td><td>In the ALT EST 2 alternative the nearest residential properties are found around 2.4 km from the landfall site. No vibration impacts are estimated to occur on residential or recreational buildings and therefore no adverse impacts on comfort are anticipated.</td></tr>
<tr><td>Waterborne transport</td><td>No impacts.</td><td colspan="2">Construction of the Balticconnector will have a short-term minimal negative impact on vessel traffic in the Estonian coastal sea and the open part of the Gulf of Finland. As the sea area bordering the route is naturally navigable throughout (except for a coastal zone of approximately 0.5 nautical miles), pipeline construction will not cause stoppages in vessel traffic – ships will adjust their trajectories and make detours around the construction area. The construction of the gas pipeline will not significantly increase the risk of shipping accidents in the Gulf of Finland.</td></tr>
<tr><td>Land transport</td><td>No impacts.</td><td colspan="2">The impacts on other traffic and traffic safety will be low and short-term. There are no differences between the alternatives. The impacts during operation will be very low.</td></tr>
<tr><td>Air emissions</td><td>No impacts.</td><td colspan="2">The emissions from and impacts on air quality and climate from the ALT EST1 and ALT EST2 alternatives during construction will be fairly low and do not differ significantly from each other. The impacts of the implementation alternatives on air quality during construction will last for two years and focus on the vicinity of the vessels participating in construction, i.e. mainly on areas further out at sea where there are few people.

The impacts on air quality and climate during the operation of the natural gas pipeline will be low, with no difference seen between the alternatives.</td></tr>
<tr><td rowspan="2">Land use and built environment</td><td rowspan="2">No impacts.</td><td colspan="2">Implementation of the Balticconnector project will implement land use objectives provided in prior plans regarding both alternatives and is not in conflict with the solution of the approved detailed plans of areas in close proximity.</td></tr>
<tr><td>The social impact of ALT EST 1 in the local context will be slighlty higher than that of ALT EST 2 because, according to the current comprehensive plan of the City of Paldiski and the drafted detailed plans the Kersalu area in force, the area has been selected for residential development.</td><td>ALT EST 2 in Pakrineeme may be preferable to some extent. It would be a positive solution under the assumption that the Balticconnector landfall will be located in the planned Paldiski LNG terminal compressor station area.</td></tr>
</table>

Environmental impacts	Zero alternative	ALT EST 1	ALT EST 2
Landscape and cultural heritage	No impacts.	Pipeline construction using the closed method will have a lower impact on the shoreline landscape than the pipeline in a trench. After the backfilling of the trench the impact on the landscape will be insignificant.	
		With ALT EST 1 at Kersalu there will be a moderately negativevisual impact on the landscape (on the klint at the landfall), and this will mostly be limited to the construction period.	The impact of ALT EST 2 on valuable landscape and cultural heritage can be moderately negative in combination with the development of LNG terminal. The main impact will not arise from the Balticconnector but from the LNG terminal.
		In the remaining mainland sections the construction of Kersalu natural gas pipeline will not have a significant impact on landscape and cultural heritage.	
People and society	No impacts.	The implementation of either alternative will have insignificant impacts on recreational conditions and tourism during construction and during operation and maintenance. In the case of ALT EST 2, the impact on recreational conditions and tourism may be moderately negative as a cumulative impact together with the Paldiski LNG terminal development.	
		The ALT EST 1 route selection is shorter for connecting other destinations (lower materials cost) but this applies only if the LNG terminal is not built in the ALT EST 2 area (otherwise the amount of piping needs to be constructed in separate places for LNG terminal and Balticconnector instead of having only one pipeline).	ALT EST 2 is a better solution from the technical and social perspectives if the LNG terminal is built in Paldiski (for the reception of LNG tankers).
		Construction of the Balticconnector natural gas pipeline will implement national priorities with regard to energy supply provided for by the national planning policy statement "Estonia 2030+". Both alternatives will have an equal overall positive impact from the construction of the Balticconnector natural gas pipeline on the state of Estonia and the business opportunities in this country.	
Mineral resources	No impacts.	No mineral deposits are located in the offshore part of the gas pipeline route and therefore the construction, operation and maintenance performed in the offshore part of the gas pipeline route will have no impact on mineral resources.	
Waste	No impacts.	The overall significance of the waste generated from the project will be low when internationally acknowledged standards and methods as well as local legislation are complied with in waste handling. There is no significant difference between the alternatives.	
Exceptional and accident situation	No impacts.	Provided that more detailed seabed surveys will be conducted to map out any munitions and barrels and the recommended pipeline protection measures will be taken, the risk of a serious accident is very low. As regards safety, in a possible gas pipeline leak there are more residences in the danger zone of the ALT EST 1 alternative in Kersalu than there are in the ALT EST 2 alternative.	
Decommissioning	No impacts.	If the offshore pipeline is left on the seabed, the resulting impacts will be of low significance or of no significance.	
		If the offshore pipeline has to be recovered from the seabed due to national legislation in force at that time, the societal and environmental significance of the impacts will be high. The environmental impacts of the offshore and onshore pipeline would correspond to the environmental impacts arising from construction.	

7.3 The most significant environmental impacts

The most significant environmental impacts of the project will arise during the construction of the natural gas pipeline. Adverse impacts during pipeline operation will be of lower significance. Impacts identified as the most significant impacts during construction are impacts on seabed, water quality, the marine environment, flora and fauna as well as nature reserves.

According to preliminary calculations and plans, a significant amount of seabed intervention measures (dredging, ploughing or jetting, blasting and subsea rock installation) will be required for pipeline protection and freespan rectification. The actual need for seabed intervention will be specified further once progress is made in technical project design, with the need for intervention for each pipeline section likely to be reduced below the level presented in this EIA report. The environmental impact assessments conducted are based on conservative assessments concerning project measures and efforts have been made to conduct them on the basis of the worst-case scenarios.

Impacts during construction

Offshore areas

Dispersion of re-suspended particles in the open part of the Gulf of Finland (outside Lahepere Bay) in the case of weak winds is mostly characterized by transportation along the gulf (in the deep layer along the deeper part of the gulf), and along the slope towards the northeast (east). This flow can be intensified or reversed due to winds. The SW-NE-oriented cloud of re-suspended particles is characteristic 4 5 days after the beginning of the work period. In the case of strong winds, the sediment would disperse further, but the diffusion of floating material is significantly higher, and therefore the decrease in water transparency near the work site would be highly limited in time (turbidity decreases faster).

Impacts on water bodies were also found to be temporary, local and low in the environmental monitoring carried out during the construction of the Nord Stream gas pipeline project. In offshore areas the duration of noise and other disturbances will also be shorter than in near-shore areas as construction work will progress faster further off the shore.

Where permitted by the ice situation, some birds, seals and occasionally also harbor porpoises are found in the open sea areas of the Gulf of Finland. No particularly important feeding areas attracting large numbers of individuals are known in the area covered by the natural gas pipeline project. Among birds, Anseriformes in particular prefer feeding in shallow areas very rarely found in open sea areas. The impacts of offshore turbidity on bird fauna are likely to be low as the impacts on fish, bivalves and other small fauna that they feed on are estimated to be very local and short-term. Deep-bottom zoobenthos will be destroyed almost all the way underneath the pipeline, but on the whole the natural gas pipeline is not estimated to pose a major risk to offshore soft-bottom benthic communities which, due to the poor oxygen situation, are quite non-diverse and have good recovery potential.

Fish populations are impacted particularly by underwater explosions, which result in behavioral changes over several kilometers and risk of injury up to hundreds of meters from the blasting site. Benthic fish are also affected by changes in the benthos, which may have either negative or positive impacts depending on the species of fish. No significant fish spawning areas can be found in the offshore zone of the project area. The impact on fisheries is reduced by the fact that the impact focus will be on mature fish.

Adverse effects on fishing in the offshore areas of the Gulf of Finland will mainly be caused by the prevention of trawling in the project area during construction. Fishing vessels operating in the area will be disturbed by increased vessel traffic, seabed intervention work, pipelaying as well as pipeline protection measures. In the Gulf of Finland however, where fairway crossings take place in the open sea, the impacts on other vessel traffic will be low as there will be plenty of space around the safety zone of the pipelaying vessel for diversionary routes, resulting in only short detours.

The most significant risks relating to the construction of the natural gas pipeline comprise the collision of installation vessels participating in pipelaying with other vessels as well as any munitions and barrels containing hazardous substances found in the seabed in the construction area. The prevention of safety incidents is the primary goal set for planning. Planning will take place in compliance with legislation as well as safety and occupational health and safety rules. Efforts will be made to prevent vessel collisions and groundings through traffic control. The disposal of munitions and barrels will be negotiated with the relevant national authorities.

Coastal area

Both alternatives (ALT EST 1 and ALT EST 2) would run across shallow Lahepere Bay and the landfalls are on Pakri Peninsula.

Damage to littoral benthic fauna can be expected to be greater when compared to the open sea. Restoration of the benthic fauna ecosystem is possible, but recovery will depend greatly on the surrounding environmental conditions and will take 1–5 years. Since the negative impact will betemporary and limited in scope, it can be classified as moderate.

The construction activity of Balticconnector has moderate impact on the local fish fauna and mostly affects certain individuals in the region and has no significant impact on the species as a whole. The construction will cause noise, increase in the concentration of sediments and substances in the water column, changes and disturbances on the seabed and changes in the food basis of fish. However, on population level the impact is reversible, and concludes with the conclusion of construction work. The impact on fishing deriving from fish fauna during the construction period is assessed as moderate and reversible.

The impact of noise and visual disturbance on birds will be direct, negative and intensive, but due to its short duration it is evaluated to be moderate. Highest risks are expected in the Pakri Natura 2000 site where sound pressure levels will be highest during the construction phase (pipelaying and trenching). In the Natura 2000 MPAs, marine mammals` acoustic thresholds should not be exceeded during pipeline construction.

Both alternative routes of the Balticconnector natural gas pipeline run through the Pakri Habitats Directive and Birds Directive sites. Significant impacts without implementation of mitigation measures cannot be excluded to concern habitat type 1110 in both alternatives. This is not a priority habitat, and mitigation measures will reduce the impact to insignificant.

In ALT EST 2, significant impact cannot be excluded for priority habitat 9180*, because it cannot be predicted how microtunneling would affect the soil structure, roots of plants or water regime. The significant impact to priority habitats 6210* and 6280* (situated outside the Natura 2000 site) in the ALT EST 2 area can be avoided by ensuring construction activities do not take place in the immediate vicinity of these sites.

The impact of planned construction work on the bird species defined as the protection aim of the Natura 2000 birds site is insignificant to moderate. In order to limit moderate impact it is necessary to apply mitigation measures. It is important to avoid negative impact on Black Guillemot (Cepphus grylle) whose only known nesting location in Estonia is located on the Pakri Peninsula that is within the impact area of ALT EST 2.

The project is estimated to have insignificant impact on the integrity of the Natura 2000 site.

In the Kersalu landfall location (ALT EST 1), where the plan is for the route to make landfall in a trench, the impact on the soil in the land section of the affected area will be significant. The microtunnel option (as planned for Pakrineeme in ALT EST 2) will cause minimum damage to the main feature in the Pakri Landscape Reserve, the Cambrian / Ordovician scarp of the Baltic Klint.

The mainland section of the Balticconnector will cover areas of very different sizes for the two alternative routes. ALT EST 1 with its 32-meter wide area directly under construction will cover around 3 ha, whereas ALT EST 2 with its direct construction zone (jacking shaft) will take up around 0.1 ha. While the ALT EST 1 route in Kersalu does not cross any protected objects of an area included in the preservation regime in force according to the environmental register, the ALT EST 2 landfall site is situated in the Pakri Landscape Reserve. However, the seaward section of the route ALT EST 1 is situated within the planned Pakri Nature Reserve that has also been added to the environmental register. The ALT EST 1 area covers sites of 5 protected plant species (category III) and 17 animal species and the ALT EST 2 area covers sites of 4 protected animal species.

The impact of the mainland section of the pipeline on the natural environment can be divided according to the alternative construction methods – whether the pipeline will be taken to the mainland in a trench (ALT EST 1) or in a microtunnel (ALT EST 2). The construction of an open trench will have a greater impact than a closed construction method, which allows the pipeline to be brought to the mainland without touching the surface formations. It is important to plan ahead with regards to the various construction techniques to ensure the pipeline construction has less impact on natural formations. Mitigation measures can be employed to minimize impacts. For this, the protected plant species growing on the route (of the ALT EST 1 alternative) should be transplanted, and also the conditions should be improved for the species in the area of bushy alvar grassland bordered by the current site, improving its light conditions by cutting the brushwood.

Impacts during operation

The impacts during the operation of the natural gas pipeline in coastal and sea area will be low. Periodic inspections and servicing and maintenance tasks may cause minor disturbances to birds and marine mammals, but these will not differ from the disturbance caused by other movement in the area.

The Balticconnector gas pipeline will cover a strip of the seabed in the Gulf of Finland. The pipeline and the subsea rock installations protecting it will form a protrusion from the seabed in many places.

In normal situations there will be no impact on water quality during the operation of the natural gas pipeline. During operation, the impacts of the pipeline on the marine environment will mainly be restricted to minor flow amendments due to morphometric changes caused by the pipeline itself and its construction (covering and protection) in areas near the pipeline, such as increased turbulence around the pipeline at faster bottom flow velocities. Changes in flow velocities and directions may affect the transport and accumulation of materials in the close vicinity of the pipeline. According to measurements carried out for the Nord Stream project, impacts only extend up to tens of meters from the pipeline.

The flow of pressurized gas in the pipeline will increase the temperature of the pipeline, which will affect the bottom sediment up to a few meters from the gas pipeline. This change in temperature will not play any practical role as regards sediment characteristics. Pipeline maintenance measures will include the addition of soil around the pipeline wherever necessary. Such measures may contribute toward changes in near-bottom flows, whereby changes in flows may cause changes in erosion or sediment accumulation in nearby areas.

During pre-commissioning, underwater noise will be generated from water intake and discharge, in which pigging will also be used. Pipeline operation noise sources can be classified as either continuous or intermittent. During operation, noise will be generated by 1) gas-borne noise from pipeline and 2) maintenance works, such as the use of vessels and helicopters. Based on data from similar reports, the noise impact from these actions will, however, be insignificant.

After construction of the pipeline and the subsequent soil restoration is complete, the gaspipe corridor will be kept open by removing trees and bushes along the gas pipeline protection zone. This is the only impact element during operation and maintenance. Consequently, only herbs and shrubs can grow on the gas pipeline. It should also be noted that construction of the route corridor will create a new open habitat, and therefore construction may help open-habitat plants to distribute. The edge effect will not extend very far into the environment, and the zone that is kept clear of trees and shrubbery will not restrict the movement of animals or cause significant habitat changes for breeding birds.

Possible damage to the gas pipeline and resulting pipeline malfunction could have consequences to human safety. The risk assessment conducted for the Balticconnector project (*Ramboll 2014b*) identified the sections where the pipeline must be protected to prevent pipeline damage Maintenance management of the gas pipeline will be carried out to ensure the pipeline will be kept in good working order and will not pose a risk to the environment.

7.4 Impacts on marine strategy objectives

The general aim of the Estonian marine strategy is to achieve good environmental status of the Baltic Sea by 2020. The development of the marine strategy takes place in three steps. The first part was completed in 2012: assessment of the current state of the marine environment, definitions of good environmental status, and environmental targets and indicators. The second step – the monitoring program – of the marine strategy was made publicly available in autumn 2014. Due for completion by the end of 2015, the final step in the marine strategy is the program of measures.

In the marine strategy, good environmental status of the marine environment is assessed using 11 descriptors and related indicators. The descriptors of good environmental status are combating eutrophication, reduction of hazardous substances, conservation of biodiversity, prevention of the spread of invasive alien species, sustainable use and management of marine resources, reducing human impacts on the sea-floor, prevention of hydrographic changes, and reducing marine and coastal littering and underwater noise. The table below covers the status of the marine environment and the impacts of the Balticconnector pipeline project by descriptor.

Table 7-3. Project impact on the descriptors of good environmental status (GES) of the marine environment defined in the marine strategy.

Descriptors of good environmental status (GES) of the marine environment			
Descriptor	**Definition**	**Current status in 2012 and assessment of achievement of good environmental status (GES)**	**Impacts of the Balticconnector project**
Biodiversity	The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.	GES has been partly achieved. Regarding marine habitats and marine species populations, there is a lack of reliable indicators for describing their status. In the coming years attention should be paid to the development of indicators and organization of monitoring.	As regards ALT EST 2 in Lahepere Bay, zoobenthos on both soft and hard substrata will be damaged. Hard-bottom communities are expected to be damaged in a small area. ALT EST 1 will result in damage only to soft-bottom communities, but construction work and rock filling is planned for a more extensive area, namely along the entire Lahepere Bay.
Non-indigenous species	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.	GES has mainly not been achieved. The priority in the near future should to work on the indicator characterizing the spatial distribution trends of non-indigenous species and applying the monitoring program.	The risk of introduction of non-indigenous species is low in conjunction with the project as transport takes place locally. The locations of the storage facilities established will be determined with a view to minimizing land and marine transport needs. Efforts will also be made to source the rocks required for seabed intervention from sites close to the pipeline route.

Descriptors of good environmental status (GES) of the marine environment			
Descriptor	**Definition**	**Current status in 2012 and assessment of achievement of good environmental status (GES)**	**Impacts of the Balticconnector project**
Commercial fish species	Populations are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.	GES has mainly not been achieved.	In the offshore areas any adverse effects will in practice be targeted at mature individuals (no population-level impacts).Considering the fact that fish fauna near the pipeline will be small during the construction work, the impact of changes in the food sources on the fish fauna is assessed as insignificant.
Food webs	All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.	GES has not been achieved in part. In the near future attention should be paid to the development of indicators and improvement of monitoring programs.	Seabed intervention, release of organic matter into water column and sediment grain size changes may affect zoobenthic community structures in the vicinity of the pipeline. Some increases in abundance and biomass of zoobenthos in the project area may be seen in several years after the construction work.
Eutrophication	Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.	GES has been partly achieved. Indicators did show achievement of GES in coastal waters, while GES in offshore areas was not achieved.	The suspended solids load and turbidity arising during construction will be relatively low, with the focus being close to the bottom. The biggest impacts will be seen close to the coast. Increased nutrient load and, on the other hand, decreased transparency, will be short-term and are not assessed to have significant impacts on algal blooms, oxygen situation, macroalgae or coastal flora.
Sea-floor integrity	Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.	GES has been partly achieved. Comprehensive status assessment was not possible due to data deficiencies. Attention in the future should be paid on the develop ment of corresponding indicators and improvement of the monitoring program.	The most significant impacts will be restricted to the pipeline construction stage. The seabed's vulnerability for change due to the project is low. Soft-bottom seabed interventions will be short-term and in part or fully reversible. Any permanent changes in hard bottoms will be low in terms of significance. After implementation of mitigation measures for benthos, the restoration of natural habitats is expected in both alternatives in Lahepere Bay.

Descriptors of good environmental status (GES) of the marine environment			
Descriptor	**Definition**	**Current status in 2012 and assessment of achievement of good environmental status (GES)**	**Impacts of the Balticconnector project**
Hydrographical conditions	Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.	Status assessment was not possible due to the fact that corresponding indicators are in the development stage.	Pipeline structures may during operation cause minor bottom flow and resulting erosion impacts in the local environment. Considering the fact that the construction of the pipeline on the seabed will not create a piled-up ridge on the seabed at the depth of 0...-13 m, there will be no impact resulting from the structure on the development of the shores of Lahepere Bay as a whole.
Concentrations of contaminants	Contaminants are at a level not giving rise to pollution effects.	GES has been mostly achieved. Comprehensive status assessment was not possible due to data deficiencies. Attention in the future should be paid to the improvement of the monitoring program in order to collect reliable data.	On the basis of surface sediment concentrations determined for the pipeline routing, contamination concentrations will not have a significant impact on the environment around the pipeline. Any biocides used during pipeline testing may have adverse impacts. The more specific implementation of the pressure test will be decided at a later date. The amounts of metal dissolving from pipeline structures during operation will be very small.
Contaminants in seafood	Contaminants do not exceed levels established by legislation or other relevant standards.	GES has been mostlyy achieved. Comprehensive status assessment was not possible due to data deficiencies regarding one indicator.	Concentrations of contaminants in the project area are low. The project is not assessed to increase the concentration of contaminants in seafood.
Marine litter	Properties and quantities of marine litter do not cause harm to the coastal and marine environment.	Status assessment was not possible due to fact that corresponding indicators are in the development stage.	All non-hazardous and hazardous waste generated during construction and operation will be disposed of at licensed and approved facilities and will not end up in water. Waste transport will be carried out by a licensed contractor. The project will not increase coastal or marine littering.

Descriptors of good environmental status (GES) of the marine environment			
Descriptor	**Definition**	**Current status in 2012 and assessment of achievement of good environmental status (GES)**	**Impacts of the Balticconnector project**
Energy, incl. underwater noise	Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.	Status assessment was not possible due to fact that corresponding indicators are in the development stage.	Underwater explosions during construction may cause significant adverse effects in the marine area close to the pipeline on any seals and aquatic birds found in the area. The adverse effects will, however, be very short-term and are not assessed to have permanent adverse effects at the species level. As Lahepere Bay is not known to be an important calving area for gray seals, the negative impact of noise from construction work to the species in Lahepere Bay and its immediate surroundings is considered to be low and temporary. The impact of noise and visual disturbance on birds will be direct, negative and intensive, but due to its short duration it is evaluated to be moderate.

Efforts will be made to minimize any adverse effects of the Balticconnector natural gas pipeline project on the marine environment primarily through pipeline design and route optimization. The strongest impacts will be seen during the construction phase, and efforts will be made during construction in particular to take the possible mitigation measures into consideration. The implementation of the project is not regarded to jeopardize the achievement of the objective of good environmental status of the marine environment.

7.5 Feasibility of alternatives and summary of comparison

As regards environmental impacts, the alternatives examined are feasible when a special focus in project design is placed on the prevention and mitigation of adverse impacts from construction. No adverse environmental impacts that are unacceptable or that could not be mitigated to an acceptable level were found during the environmental impact assessments of the project alternatives.

The comparison includes the environmental impact of three alternatives:

- ALT 0, the zero alternative in which case the project will not be implemented. The natural gas pipeline from Paldiski to Ingå will not be constructed, and there will be no impact on the environment at this location. This situation is described in chapter 5.
- ALT EST 1 natural gas pipeline with the landfall in Kersalu, up to the planned compressor station
- ALT EST 2 natural gas pipeline with the landfall in Pakrineeme.

The comparison is shown in Table 7-2. Comparison of environmental impacts is based on planned activities, described in technical preliminary design (preFEED).

According to preliminary calculations and plans, a significant amount of seabed intervention measures (dredging, ploughing or jetting, blasting and subsea rock installation) will be required for pipeline protection and freespan rectification. The actual need for seabed intervention will be specified further once progress is made in technical project design, with the need for intervention for each pipeline section likely to be reduced below the level presented in this EIA report. The environmental impact assessments conducted are based on conservative assessments concerning project measures and efforts have been made to conduct them on the basis of the worst-case scenarios. The measures proposed in this report by experts to mitigate these impacts are effective (see chapter 9).

In the area of ALT EST 1 soft and sandy sediment dominate on the sea bottom. The phytobenthic communities in this area are mainly formed by higher plants and have a high biomass value. In the shallow coastal sea area of ALT EST 2 a rocky type of seabed with characteristic communities of phytobenthos dominate.

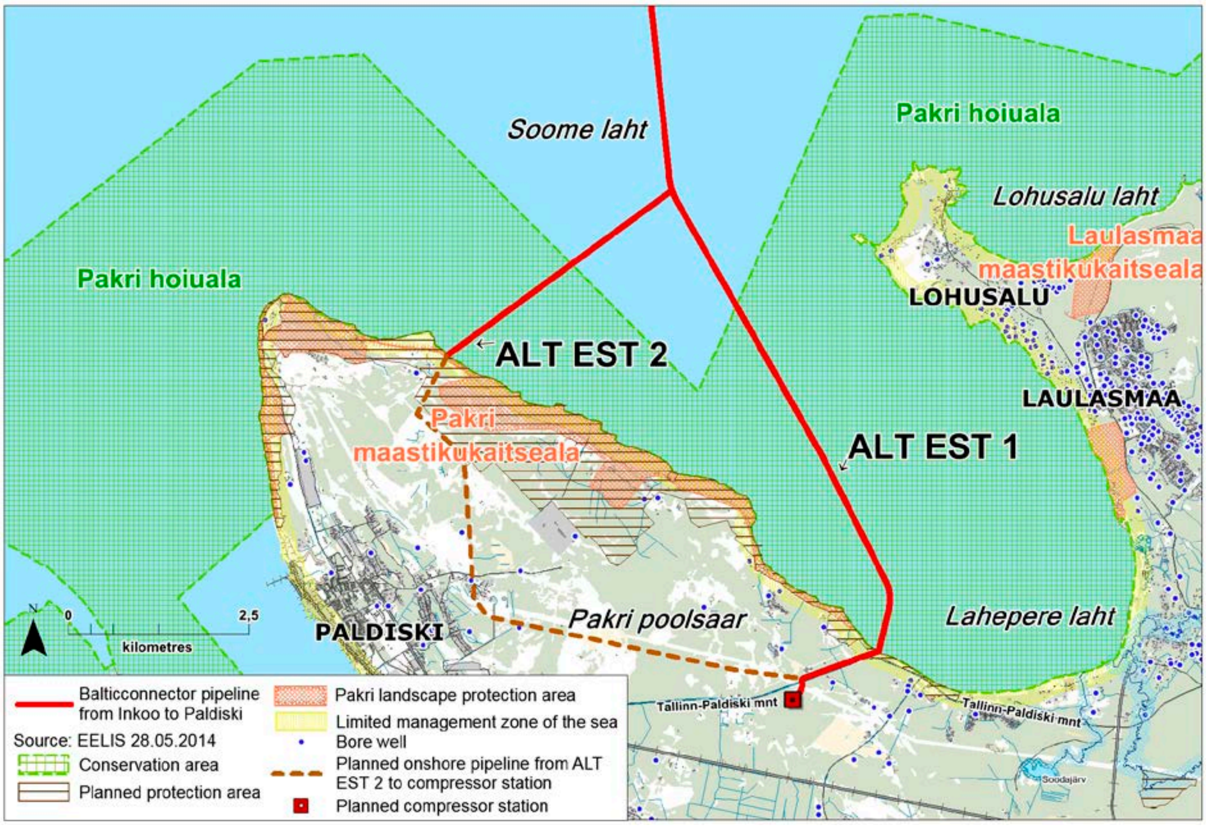


Figure 7–1. Planned onshore pipeline from ALT EST 2 to the compressor station.

At the depth of 67 meters rocky seabed is replaced by sandy sediments with a lower biodiversity of seabed flora. Therefore, it can be assumed that impacts of ALT EST 2 are lower than impacts of ALT EST 1 for phytobenthic communities as after the construction works the rock filling enables the recovery of seabed flora characteristic to the region.

Zoobenthos on both soft and hard compact substrata would be damaged in ALT EST 2 in Lahepere Bay. Alternative ALT EST 1 would only face damage of benthic fauna communities on soft seabed, but the rock fill is planned to be deposited on a larger area. The zoobenthos is expected to recover after the completion of construction works in both alternative construction areas.

Changes to the seabed on the pipeline route can have a negative impact on the spawning grounds. Based on the dispersal of the most important species in Lahepere Bay, a smaller impact would be ensured by the ALT EST 1 alternative, which goes through an area where the number of species is lower than on the route of ALT EST 2. In general, the area of the planned gas pipeline is small when compared to the area of the bay, and the impact caused by changes on the seabed on the spawning areas of Baltic herring (*Clupea harengus membras*) as well as other fish is likely to be insignificant with both alternatives.

ALT EST 1 will entail a lower negative impact on the planned conservation area, flora (on shore) and landscape in the mainland section. There will be a higher negative impact directly on the soil and bedrock of Kersalu bank. In this section of the bank, covered by a rubble slope, the plan is to install the pipeline into a trench that would cut deeply into the limestone and sandstone bank. Habitats located in this section up to 120 m inland from the shoreline within the planned Pakri nature conservation area would also be destroyed.

These impacts can be mitigated or avoided by using the closed construction method through the bank, in which case the impact of ALT EST 1 will be even lower than that of ALT EST 2.

The main differences are the total length of the offshore pipeline section as well as the onshore section to Kersalu, i.e. the connection point of the two pipeline routing alternatives to the planned Kiili–Paldiski D category natural gas pipeline:

- For ALT EST 1 the offshore section is approx. 7 km long and the mainland section 1.3 km long.
- For ALT EST 2 the offshore section is approx. 4 km long, and from there the mainland section through Pakri peninsula to Kersalu is approx. 8.5 km long.

With ALT EST 1 the offshore section is approx. 3 km longer and the mainland section 7.2 km shorter than those of ALT EST 2.

A possible mainland section from Pakrineeme to Kersalu and the compressor station are not included in this currently assessed Balticconnector natural gas pipeline development (see Figure 7–1).

The construction of the ALT EST 2 pipeline section up to Pakrineeme is feasible if the LNG terminal is constructed there. The strategic environmental impact assessment of the thematic plan of Paldiski LNG terminal (OÜ E – Konsult work no E1177, June 2012) states that: "This thematic plan enables the opportunity to change the location of the compressor station, positioning it adjacent to the planned LNG terminal. The LNG terminal and the gas compressor station located at the planned location have to be connected using a high-pressure gas pipe. The route of the planned gas pipes runs mostly in parallel to existing high voltage power lines, and on the area of a planned wind farm near the LNG terminal."

The worst scenario for the environment of the Pakri Peninsula would be if the Balticconnector natural gas pipeline was brought to Kersalu and the LNG terminal was constructed to Pakrineeme together with an additional 8.5 km gas pipeline through the Pakri Peninsula up to the Kersalu compressor station.

If the LNG terminal is not constructed in Pakrineeme, the preferred alternative is ALT EST 1 as its mainland section is 7.2 km shorter and its impact on the natural environment of the Pakri Peninsula as a whole will be less disruptive. Significant impact during the construction period due to the planned activities can be mitigated and will not exclude the construction of the natural gas pipeline.

The project is estimated to have insignificant impact on the integrity of the Natura 2000 site. Some habitats, and possibly species, will face impacts which can be reduced by appropriate mitigation measures. The potentially high impact on habitat 1110 in the ALT EST 1 area can be excluded by implementation of mitigation measures. The impact on habitat 9180* in the ALT EST 2 area is not excluded due to lack of information about marking of the microtunnel route on the mainland and the exact location of the microtunnel head.

The ALT EST 1 alternative is assessed as the alternative with a lower impact on the Pakri Habitats Directive site when compared with ALT EST 2.

In addition to adverse impacts, the implementation of the project will also have positive environmental impacts. The construction of the Balticconnector natural gas pipeline would contribute to the development of the natural gas market in Estonia. The positive impacts on employment and livelihoods will also not be realized if the project is not implemented. If the project is not implemented, neither the adverse nor the positive impacts of the project will be realized.

8 UNCERTAINTIES RELATED TO THE ASSESSMENT WORK

Uncertainty factors are part of the environmental impact assessment process and will be taken into account in the assessment work. There are facts relating to the assessment that are not known in sufficient detail. This causes uncertainty in predicting impacts. In addition, not all impacts can be measured nor are they unambiguous, which causes additional uncertainty in the assessment. In addition to quantitative assessment techniques, expert assumptions are needed.

Uncertainty factors include, for example:

- time schedule of the project;
- other physical conditions in the Gulf of Finland vary in time, and the impacts from operations like dredging differ depending on the conditions at the time of the operation;
- survey and modelling techniques – although using the best available techniques in the assessment – can develop from the time of the assessment;
- technical design of the project, which can be in the process of being finalized at the time of the assessment.

The 'precautionary principle' is applied throughout the assessment, meaning that the risk estimates represent the worst-case scenarios.

The EIA was conducted on the basis of existing material, data and information as well as field visits and additional fieldwork during 2014. A list of the main material consulted during the EIA process is given in the report (see chapter 11).

There are no apparent gaps in the material that was made available, collected or in other ways used by the consultants for the EIA.

The fieldwork for surveying biotopes and biodiversity was conducted over a longer period as the occurrence and observability of plants and animals are highly seasonal. However, the occurrence of some rare and valuable species of plants and animals within the project area cannot be excluded on the basis of the fieldwork conducted in this study.

A trained fieldworker can deduct a rather clear picture of the potential and possible occurrence of rare and valuable species and habitat types by surveying the present biotopes also at the very end of the season. Additionally, all biotopes found within or near the project area are altered and/or impacted by human activities.

There are a lot of uncertainties relating to underwater noise propagation. The conservative approach generally overestimates noise levels at large distances. Temperature gradients, bottom topography and currents are noted to cause sound levels to attenuate more rapidly than expected from geometric spreading.

On the basis of the studies conducted so far it is not possible to conduct a specific environmental risk assessment regarding munitions and barrels as these are yet to be mapped out in detail. More detailed seabed surveys will be carried out at a later project design stage, with more detailed mapping of munitions and barrels also taking place in this context.

The risk assessment concerning the period of operation of the Balticconnector natural gas pipeline covers a natural gas pipeline routing alternative in Estonia, ALT EST 1, and the Finnish alternatives ALT FIN 1 and ALT FIN 2 as well as the LF2 landfall, but the risk assessment does not cover the Estonian pipeline routing alternative ALT EST 2 or the Finnish landfall alternative

LF1. The risk assessment will be specified further once more detailed seabed surveys to thoroughly map out the munitions and barrels have been completed. The risk assessment conducted can also be regarded as indicative for the Estonian ALT EST 2 alternative and the Finnish LF1 landfall alternative.

The uncertainties concerning vessel emissions are to do with vessel traffic volumes and fuel consumption, the estimates of which at this point are preliminary. The volume of rock required for seabed intervention was not assessed separately for the ALT EST 1 and ALT EST 2 alternatives. The amount of earthworks was not assessed for the ALT EST 2 landfall alternative. Even considering the uncertainty factors, the project's impacts on air quality will be fairly low.

There will be temporary worksite with an area of 10,000 m² for the construction of the microtunnel. Landfall ALT EST 2 in Pakrineeme is located in the area of the adopted detailed plan of Paldiski LNG terminal in the property called Male (see section 5.2.9.1, Figure 5-76). The exact size, shape and position of the shaft of the hydraulic jack and the construction site of the micro-tunnel of ALT EST 2 in Pakrineeme is not specified in the pre-FEED report (*Ramboll 2014a*). The exact position of the shaft and construction site of the microtunnel inside the determined building area of the LNG terminal detailed plan (see section 5.2.9.1, Figure 5-76) will be provided with the building design documentation.

According to Government decree "Gaasipaigaldise kaitsevööndi ja D-kategooria gaasipaigaldise hooldus-riba ulatus" (*RT I 2002, 58, 367*), the protection zone of the category D gas pipelines with a diameter exceeding 500 mm is 10 m. Activities prohibited in the protection zone area according to section 10(2) of the Gaseous Fuel Safety Ac (*RT I, 29.06.2014, 26*) include the cultivation of trees. It is uncertain if a protection zone will also be required along the microtunnel route for the ALT EST 2 landfall through Habitat type 9180* – bank forests.

The pipeline will be tested and cleaned before the operation phase. The pipeline will be filled with seawater containing biosulfite ($NaHSO_3$) and/or biocide. After the testing, wastewater will be treated and discharged to the sea. However, it is not known yet where the possible sedimentation basins for wastewater treatment will be situated, how much space they would need and where the exact discharge point will be.

The main technical documentation used as input for the environmental impact assessment was the pre-FEED study of the Balticconnector offshore pipeline (*Ramboll 2014a*). Technical descriptions given in the pre-FEED documentation will be provided with greater detail in FEED due to take place next.

Taking into account the fact that there are uncertain-ties, the impacts have been evaluated on base of the worst-case scenarios in conservative way.

9 MITIGATION MEASURES

The mitigation measures given in this section apply to both assessed alternatives – ALT EST 1 and ALT EST 2.

Table 9-1. Mitigation measures.

IMPACT	MITIGATION MEASURE
NOISE, VIBRATIONS AND AIR EMISSIONS	· It is advisable to use the so-called warning sounds at blasting sites to scare away any individuals in the area before major blasting. · Report visual monitoring (presence of marine mammals) and acoustic monitoring (monitoring noise levels) at least inside the dangerous zone before, during and possibly after each blasting session is highly recommended. Any presence of marine mammals in the dangerous zone in the 30-minute period before blasting should prevent the blasting operation. This mitigation recommendation may have large impacts on the cost and planning of the operation. Therefore, it is recommended to refine the estimate of the dangerous zone (which may vary a lot from place to place) in order to restrict the volume of water to clear. · Construction work should be organized so that noisy work is not done during the nighttime (23:00–07:00) (*Regulation no 42 by Minister of Social Affairs*) and to avoid dust and its dispersibility on dwelling yards. The level of internal combustion engine emissions should not increase the allowed marginal rates established for specific car makes during production.
MARINE BENTHOS	· During construction work it is necessary to choose technologies and working principles that will cause as little seabed damage in the flora zone as possible. · For backfilling of the trench in the phytobenthic zone, the same natural material must be used that was extracted from the area during construction work. This allows the recovery of seabed flora characteristic to the area. · Dredged sediment must be stored and kept outside Lahepere Bay area if possible according to its natural conditions in order to use it later for backfilling the trench. · In the shallow Lahepere Bay, pipeline pre-lay and post-lay activities must be performed for as short a period as possible.
MARINE BIRDS	· Avoid carrying out work during the nesting period of birds from the beginning of April until the end of July. · Choose vessels and working practices that minimize the amount of sediments released.
PINNIPEDS	· During the operation of the pipeline, avoid maintenance work during February-March, the calving period of the gray seal. During this period it is advisable to use lower vessel speeds for moving in the bay. · At blasting sites use pre-signals to scare away any individuals in close proximity that might be harmed by the shockwave of blasting.

IMPACT	MITIGATION MEASURE
FISH FAUNA	· Avoid construction work during the spawning season between the beginning of April until the end of July. · Use warning signals before blasting to drive fish away from the danger zone of the working area.
SHIP TRAFFIC AND FISHING	· Thorough information presented to local fishermen and fishing enterprises as well as methodical supervision if necessary in order to limit risks posed to the pipeline as well as fishing vessels and fishing instruments.
LANDSCAPE	· The construction area should be narrower on alvars, up to 10 m on both sides of the axis of the pipeline. · The entire mainland pipeline section is to be restored after construction using soil of the same consistency as the surrounding area, and using a mixture of alvar plant seeds common to the area instead of standard grass. · If landfall ALT EST 1 is constructed using the bottom-pull method with an open trench, the landscape should be restored in order to ensure visual quality.
SOIL	· Use the environmentally safer closed construction method if technically possible in the Kersalu landfall area (ALT EST 1) to preserve the appearance of the landscape of the klint scarp.
NATURAL ENVIRONMENT ONLAND	For mitigation measures see 6.6.5.1.2; 6.6.5.2.2; 6.6.5.3.2 Prevention measures concerning protected objects: · Use the closed construction method if technically possible in the Kersalu landfall area (ALT EST 1) to preserve the protected species. · Shifting the route away from the area of sites or by compensation through transplanting the population; · In the detail design phase the exact natural gas pipeline route and construction method should be selected with a view to minimizing impact on nature. · Using the horizontal drilling method in pipeline construction where it is technically and economically possible in order to minimize impact on nature. Suggestions for protecting the Least Flycatcher and other forest birds and forest animals: · Schedule the construction phase for a period of no major animal migration. Avoid forest cutting and freight-out and major construction works from April 15 to July 15. · Preserve the area and integrity of the forest as much as possible. · Use such plant species in the restoration on top of the backfilling that are suitable as feed for caterpillars (for coppers e.g. sorrels; for blues e.g. vetches and clovers; for skippers e.g. Gramineae, reed bent and purple moor grass; for purple emperor e.g. willows and great willow). · Leave smaller heaps of stone as shelters for common adder and viviparous lizard.
NATURA SITES	For mitigation measures see 6.7.5 · Construction work should be focused on reducing damage to protected habitat areas at sea as well as on mainland. · The construction methods should be planned to minimize the impact on priority habitat 9180* in ALT EST 2. · Potential significant impact can be avoided by using methods that only have temporary consequences and guarantee the restoration as well as consistency of habitat types. · The material excavated from a habitat during construction can be used for backfilling the trench in habitat types listed in the Habitats Directive. · When restoring characteristics of damaged habitat types it is necessary to focus on restoring the landscape as well as on seabed quality in the upper layer. · It is not allowed to use contaminated sediment for filling the trench. · Construction and other activities must be planned in a manner that does not damage habitat types of primary importance or deteriorate their condition. · Construction activities within the Pakri Birds Directive site should be avoided in the bird nesting period.

10 ENVIRONMENTAL IMPACT MONITORING PROGRAM

The proposals presented in the following sections for the principles of an environmental impact monitoring program were drawn up in conjunction with the environmental impact assessment of Gasum's Balticconnector project.

Suggestions given in this EIA report for environmental impact monitoring may differ to some extent from suggestions given in the Finnish EIA report due the different environmental conditions and as well as due to differences in legislation.

Environmental impact monitoring aims to:

- produce information about the project's impacts;
- find out which impacts result from the implementation of the project;
- find out how well the results of the impact assessment correspond to reality;
- find out how well the measures to mitigate adverse impacts have succeeded; and
- launch the necessary measures in case of any unforeseen, significant adverse impacts occurring.

10.1 Water quality and marine environment

During pipeline construction, the extent of turbidity, water quality and biological factors will be monitored.

Water quality monitoring will focus on the areas affected by those measures causing the highest adverse impacts on the marine environment, which will be specified further at later stages of the project once progress is made in pipeline design. Automated continuous measuring instruments can be utilized in the monitoring, providing comprehensive data about turbidity impacts and their duration. Issues such as oxygen. solids, nutrients and harmful substances such as heavy metals and organic compounds will be analyzed from water samples. HELCOM or national standards will be complied with in the monitoring. A separate monitoring program will be drawn up for munitions clearance, in which marine and other environmental impacts will also be taken into consideration.

The sites where the water quality monitoring (suspended matter, nutrients, contaminants, dissolved oxygen, currents) has to be carried out in Estonian waters include at least the deepest section of the pipeline, where fine sedimentshave the highest concentrations of contaminants; that is also where the dispersal of suspended matter might take place to a relatively large extent; in addition, the actual release of substances into the water column will very much depend on the oxygen conditions in the near-bottom layer, and the released amounts will have to be checked against the present assessment results.

In the Lahepere Bay and the area just outside of the bay where construction will result in highest levels of turbidity (according to the present assessment results), continuous measurements of turbidity and currents (with near real-time data delivery) are suggested to avoid spreading of suspended matter towards the inner bay and to estimate the total sediment load on different areas more accurately.

During construction work at sea, the dispersal of suspended matter must be monitored to prevent concentrations > 10 g/m2 over an extensive area.

Water quality monitoring should also be carried out during the construction period and as recommendable also one year after the completion of construction work (turbidity, oxygen, nutrients and hazardous substances). Benthos should be monitored before, during and after the construction work (for at least 3 years).

As regards macrophytes, the monitoring will cover changes taking place in and between lines and cumulative impacts between and within all lines as well as diversity. Soft-bottom benthic fauna can also be monitored by repeating the sampling on the same sites as in the survey of the current status. The Before-After-Control-Impact (BACI) approach is a generally accepted method for the assessment of conditions before and after construction work. The overall purpose of the monitoring is to assess the situation before/after construction and natural variation between years in the biota.

It is recommended that the habitats within the Lahepere Bay be monitored yearly for a minimum of five years after construction until the acceptable recovery level of habitats has been reached.

The marine benthic habitats must first be researched after the completion of the work and then once a year during the expected recovery time.

10.2 Fish, birds and marine mammals

The fisheries impacts will be monitored during project implementation on the basis of a fisheries monitoring program what should be determined. According to the assessment, there is no need for fisheries monitoring during operation.

The monitoring program implemented during construction will be employed to monitor fish breeding, changes in the structure of fish stocks, and professional and recreational fishing in the area. For the offshore areas the monitoring focus will be on professional fishing surveys and the monitoring of catches per statistical rectangle. Where necessary, impacts during explosions can also be monitored using methods such as echo-sounding.

The before-after, control-impact design is proposed as the monitoring setup. Clear monitoring hypotheses and statistical methods to test these hypotheses will be presented in the monitoring program.

For pre-and post-surveys to be comparable, it is advisable to use the same methodology continuously.

Method: fishing with standard survey nets (*TÜ Mereinstituut 2013* and *Thoresson 1996*). Time: May and August, altogether twice a year (*TÜ EMI 2013*).

The first survey should be arranged during or immediately after the construction and pre-commissioning period of the pipeline. Subsequent surveys should be carried out once a year up to 3 years after the first survey. If the results from the third survey (2nd year) do not show any negative trends, there will be no need for a survey on the 3rd year.

Impacts on birds and marine mammals in the marine area can be monitored during intervention measures and pipelaying. If signs of disturbance among animals are observed in the monitoring carried on-board vessels, the work can be discontinued temporarily, mitigation measures can be increased, or work methods can be changed.

For pre-and post-surveys to be comparable, it is recommended to use the same methodology continuously. Bird surveys should therefore consist of three separate parts: nesting, ship and coastal surveys.

Nesting survey
Method: charting the nesting territories of birds (*Bibby 2000*).
Time: May–June, twice each month.
Ship survey
Method: Bird census along the pipeline-route on board a ship (*Durinck 2005*).
Time: Spring, summer, autumn, winter. Altogether 4–5 times per year.
Coastal survey
Method: bird census from 6 observation points along the Lahepere bay coastline (EOÜ, 2014)
Time: once or twice a month during one year. Altogether 20–21 times.

The first survey should be arranged during or immediately after the construction and pre-commission period. Subsequent surveys should be carried out once a year up to 3 years after the first survey. If the results of the second survey do not show any negative trends, there will be need for further surveys.

10.3 Noise

If necessary, noise during construction can be monitored through noise measurements near sound sources and recipients subject to disturbance. Correspondingly, the situation during operation can be monitored through sound source and environmental noise measurements as well as a noise model.

The monitoring of underwater noise can, for example, be carried out using hydrophones measuring and recording underwater noise in sites regarded as important during the noisiest period of the entire construction process (including explosions, largest-scale excavation). Once more detailed project designs are available, noise propagation and risk factors relating to the noisiest activities can be mapped using more detailed underwater noise models utilising methods including the underwater noise modeling logic available from the BIAS project.

10.4 Shipping, people and society

The Gulf Finland Reporting System (GOFREP) is a mandatory reporting system for ships of 300 gross tonnage or over. Vessel traffic is controlled by Vessel Traffic Service (VTS) centers in Helsinki, Tallinn and St Petersburg, which provide vessels with shipping information for the Gulf of Finland. The aim of the system is to increase maritime safety in the area, improve the protection of the marine environment, and monitor compliance with the International Regulations for Preventing Collisions at Sea (COLREGs). The GOFREP area covers the international waters in the Gulf of Finland east of the Western Reporting Line. Finland and Estonia have also introduced mandatory reporting systems in their national waters outside their VTS areas.

During project construction, the pipelaying vessel will be monitored using the GOFREP system like all other vessel traffic in the Gulf of Finland.

It is important for local residents to be informed of the status of the project's environmental monitoring. Monitoring findings should be published regularly in conjunction with the project operator's normal communications. The project itself is not going to cause environmental impacts resulting in any special need for monitoring from the perspective of people and society.

It should be monitored whether waste created during natural gas pipeline construction is recycled in locations meant for such purpose and in an environmentally sound manner.

10.5 Nature

Onland protected species at the locations of the natural gas pipeline route where mitigation or compensation measures have been taken should be monitored in order to establish the rate of success of the measures and to take any additional measures if needed.

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APPENDICES AND SEPARATE REPORTS

APPENDIX 1 EIA PROGRAM AND DOCUMENTATION

The EIA program is available on the Gasum website (http://www.balticconnector.fi).

APPENDIX 2 APPROVAL OF THE EIA PROGRAM BY THE MINISTRY OF THE ENVIRONMENT

Mrs. Veronika Verš
EIA expert
Ramboll Eesti AS
info@ramboll.ee

Yours: 23.05.2014 nr PK-17

Ours: 15.07.2014 nr 11-2/14/1093-9

Approval of Balticconnector project Environmental Impact Assessment programme

Dear Mrs Verš

The Ministry of the Environment has reviewed the Balticconnector project's Environmental Impact Assessment (EIA) programme.

Based on the Environmental Impact Assessment and Environmental Management System Act (EIA Act) § 10 section 1, section 3 points 2 and 4-5; § 13; § 18 sections 2 and 3, we approve of the aforementioned programme.

The Ministry of the Environment is obligated under the EIA Act § 19 section 1 to notify of the approval of the programme in the publication Ametlikud Teadaanded (Official Notices), and in writing to the interested parties within 14 days of the approval decision. Therefore, the developer must pay the state fee of 6.39 euros for the announcement of the programme approval in the Official Notices within 10 days of the present verdict. The state fee can be paid on one of the following Ministry of Finance bank accounts:

SEB Pank, EE891010220034796011;
Swedbank, EE932200221023778606;
Danske Bank A/S Eesti filiaal, EE403300333416110002;
Nordea Bank Finland PLC Eesti filiaal, EE701700017001577198.

Whilst paying the state fee, one should note in the reference number box 2900078680 and in the explanations box that the payment is for the approval notice of the Balticconnector project's EIA programme. Proof of the state fee payment should be sent to the Ministry of the Environment.

Considerations relating to this decision are set out below.

Reasons for the decision and considerations

1. Legal basis and competence

The Ministry of the Environment is, according to the EIA Act § 10 section 1, the supervisor of the Balticconnector EIA, as the significant environmental impact of the activity may be transboundary.

In order to approve or disapprove of the EIA programme, the Ministry of the Environment, as the EIA supervisor, must assess the content of the programme as well as the compliance of the EIA procedure with regulatory requirements. An overall assessment of the quality of the EIA programme and the legality of the proceedings must be given.

The decision of the approval of the programme has been made under the EIA Act § 10 section 1, section 3 points 2 and 4-5; § 13, § 18 sections 2 and 3.

2. The proceedings

Due to the superficies license application which was presented by Gasum Oy on 14.05.2013 and EIA Act § 6 section 1 point 17, the planned activity may have significant environmental impact. Therefore, the Government launched a superficies license process and the EIA on 12.12.2013 with decision No. 555.

Since the implementation of the project may result in significant transboundary impacts, the Ministry of the Environment in its letter no 11-2/14/1093-1 dated 07.02.2014, taking into account EIA Act § 30 section 3, notified Latvia, Lithuania, Russia and Finland and asked whether they want to take part in the transboundary EIA process. Latvia and Lithuania replied that they do not want to participate in the EIA process; Finland replied that they want to take part in the proceedings. The letter sent to Russia never made it there, however, according to information received from Finland, Russia wants to participate in the EIA process. The views received from countries can be found in the Annex of the EIA programme. In addition, the information concerning the commencement of the EIA was sent by letter on 07.02.2014 to Denmark, Germany, Poland and Sweden, who had earlier via e-mail expressed their views that they do not want to get a formal notification about the initiation of the transboundary EIA.

Since the Balticconnector project entails a pipeline between Estonia and Finland, both countries are mutually the party of origin and the affected party. Therefore, it is agreed that the EIA is done jointly in both countries. An explanation of the transboundary EIA can be found in the EIA programme Chapter 2.1.2 and information about the compilation of the EIA report has been sent in reply letter to the Environmental Board dated 21.05.2014. That can be found in the EIA programme's Appendix.

The Balticconnector EIA programme was submitted for approval to the Ministry of the Environment for the first time on 23.05.2014. Since the EIA programme had some shortcomings, the supervisor returned the programme with a letter dated 20.06.2014 and asked to improve it. The expert sent an improved and revised programme for re-approval with a letter dated 30.06.2014.

3. Publication of the EIA programme

3.1. Notification of the publication of the EIA programme

The conditions and methods of notification of public display and public meeting of the EIA programme are established in the EIA Act § 16 sections 2, 3 and 4.

The notification of the Balticconnector EIA programme publication was made on 07.02.2014 in the Official Notices, 10.02.2014 in the newspaper Eesti Päevaleht, 07.02.2014 in the newspaper Harju Elu. On 07.02.2014 it was published on the Ministry of Economic Affairs and Communications, and on Paldiski city's website. On 10.02.2014 the notification was published on Ramboll Estonia's website. The information was also available on the developer's website. A written notice dated 06.02.2014 was sent to all proceeding parties in accordance with EIA Act § 16 section 3. Additionally, further information about the public meeting proceedings on the project were published in the newspaper Eesti Päevaleht on 10.04.2014 and in the newspaper Harju Elu on 11.04.2014. The publication notice entailed the information requested by EIA Act § 16 section 4.

3.2. The public display and meeting of the EIA programme

According to EIA Act § 16 section 1, a public display (duration at least 14 days) will be organized to introduce the planned activity and the EIA programme, after which there will be a public meeting.

The public display of the programme lasted approximately two months (10.02.2014 – 07.04.2014). The programme was available at the Ministry of Economic Affairs and Communications, Paldiski City Government, the Ministry of the Environment, as well as on their websites and also on Ramboll Estonia's website. Suggestions and objections could be submitted to the Ministry of Economic Affairs and Communications until 04.07.2014.

Public meetings on the EIA programme were held at the Paldiski's Russian Primary School on 15.04.2014 and at the Ministry of Economic Affairs and Communications on 16.04.2014. 27 people took part in the first meeting and 22 people in the second, among whom were the decision-maker, the developer and the EIA expert.

3.3. Suggestions, objections and questions submitted about the EIA programme, and taking them into account

In accordance with EIA Act § 16 section 5, everyone has the right to familiarise with the programme and other relevant documents during the public display and meeting. As well as submit suggestions, objections and questions, and get answers to them.

During the public display of the EIA programme, written suggestions and opinions were submitted by Laulasmaa resident Marek Maasik, Rescue Board (North division), the National Heritage Board, the Environment Board (Harju-Järva-Rapla region), Ministry of Agriculture, Ministry of the Environment, neighboring property owner Jane Mölder, and Pakrineeme Sadama OÜ. The expert replied to the received suggestions and comments in writing dated 21.05.2014. All letters can be found in the Annex of the EIA programme, also a table with an overview about taking into account the comments.

At the public meeting the planned activity and the EIA programme was introduced. Questions were answered verbally at the meeting.

In light of the foregoing, the EIA programme publication procedure has been lawful.

4. EIA programme's and EIA expert's compliance with the established requirements

The EIA programme was compiled by experts from Ramboll Estonia and Ramboll Finland. The leading EIA expert was Veronika Verš, whose license KMH0149 is valid until 01.03.2018. On the EIA expert's license industry is assigned as the competent area of activity to be assessed; landscape and social economics are assigned as the competent area of impacts to be assessed. The list of the expert group can be found in the EIA programme's Chapter 2.4. The EIA report will be compiled by an expert group that consists of representatives from several different companies. The list of the representatives can be found in the programme's Chapter 2.5. The leading EIA expert during the compilation of the report will be Rein Kitsing from AS Merin, whose license KMH0020 is valid until 09.04.2016. On the EIA expert's license the following competent areas of activity are assigned: agriculture, land development, energy, wastewater treatment, waste management, construction, water and sanitation, maritime and port construction, dredging and dumping solids into water bodies, forestry, transport and traffic; and competent areas of impacts: soil and terrain, water pollution, water levels and waste generation.

The Balticconnector EIA programme has been prepared in accordance with EIA Act § 13. The EIA programme contains the following: description of planned activity (including the objective), description of alternatives, content of the environmental impact assessment (including an overview of expected environmental impacts and assessment methods), time schedule of EIA procedures and permitting, and EIA parties (including information on the developer and the expert group).

The Ministry of the Environment has verified the compliance of the EIA programme and the EIA process with established requirements, and has found that there are no circumstances that prevent the programme from being approved according to the EIA Act § 18 section 3.

Sincerely

(Digitally signed)

Keit Pentus-Rosimannus
Minister

For information: Gasum Oy Eero.Isoranta@gasum.fi
Ministry of Economic Affairs and Communications

Maris Malva 626 0742; maris.malva@envir.ee

APPENDIX 3 EIA REPORT PROCEDURE DOCUMENTATION

To be completed later.

APPENDIX 4 IMPERIA TOOL CLASSIFICATION CRITERIA

Imperia: Classification of impact components

The multi-criteria decision analysis (MCDA) practices and tools developed in the EU LIFE+ IMPERIA project (*https:www.imperia.jyu.fi*) were employed as appropriate in the assessment of the significance of the environmental impacts reported in the EIA report of the Balticconnector project. The following classification criteria for the components of impact significance were utilized in the impact assessment work. Criteria are given for the components of impact in case the separate expert opinion was not composed.

1 SOIL, BEDROCK AND GROUNDWATER 2

2 NOISE 3

3 VIBRATIONS 4

4 HYDROLOGY AND WATER QUALITY 5

5 BIRDS, FISH AND MARINE MAMMALS 6

6 BIODIVERSITY 8

7 SETTLEMENT STRUCTURE, BUILT ENVIRONMENT, PLANNINGS AND LAND USE 10

1 SOIL, BEDROCK AND GROUNDWATER

Sensitivity of the receptor

Legislative steering, societal significance, susceptibility to change

Very high	Soil and bedrock: The receptor is determined as geologically very or exceptionally valuable. In addition, the area is in its natural state. It has high landscape value. Groundwater: Classified as a Quality class I and important groundwater area used extensively for water supply. Built-up area or settlement with receptors that are very sensitive to changes in groundwater level.
High	Soil and bedrock: The receptor is determined as geologically valuable. In addition, the area is quite close to its natural state. It has clear landscape value. Groundwater: Classified Quality class I groundwater area where there is possibly also a water intake structure. Settlement or area with residents with receptors that are sensitive to changes in groundwater level.
Moderate	Soil and bedrock: The receptor is determined as geologically quite valuable. In addition, the area is partly in or close to its natural state. It has only minor landscape value. Groundwater: Quality class II groundwater area. An area with individual wells of water intended for human consumption or a few structures and buildings sensitive to changes in groundwater level.
Low	Soil and bedrock: The receptor's soil or bedrock does not have particular value on the basis of its geological characteristics. In addition, the area is not in its natural state. It has no landscape value. Groundwater: A glacial till area with no classified groundwater area. Groundwater is not used for human consumption. There are no structures or buildings sensitive to subsidence.

Magnitude of change

Very high ----	The quantities of material handled are very large. High adverse impacts on soil and bedrock or the environment are caused by the activity. A clear and large change in the quantity and/or quality of groundwater clearly exceeding the limit values set for water intended for human consumption. Current use is prevented.
High ---	The quantities of material handled are large. Adverse impacts on soil and bedrock or the environment are caused by the activity. A change in the quality and/or quantity of groundwater restricting its current use and/or exceeding limit values.
Moderate--	The quantities of material handled are moderate. Some adverse impacts on soil and bedrock or the environment are caused by the activity. An impact on groundwater quality that remains within the limit values set for water intended for human consumption and/or impact on groundwater quantity restricting groundwater sourcing to some extent.
Low -	The quantities of material handled are small. Only minor adverse impacts on soil and bedrock or the environment are caused by the activity. There are no impacts on current water supply use. A change in quality and quantity of groundwater that remains within the limit values.
No impact	No impact on soil or bedrock and no adverse impacts on soil or

	bedrock or the environment. No impact on groundwater.
Low +	Nr = not relevant
Moderate ++	Nr
High +++	Nr
Very high ++++	Nr

2 NOISE

Onshore/above-water noise

Sensitivity of the receptor

Legislative steering, societal significance, susceptibility to change

Very high	Settlement without industrial, traffic or other noise-generating activities. No anthropogenic ambient noise. A very large number of sensitive disturbable receptors, such as holiday residences, schools and day care centers.
High	No industrial, traffic or other noise-generating activities. Very little or no anthropogenic ambient noise. A large number of sensitive disturbable receptors, such as holiday residences, schools and day care centers.
Moderate	Some industrial or other noise-generating activity, some traffic, moderate ambient noise level. Quite a large number of sensitive disturbable receptors, such as holiday residences, schools and day care centers.
Low	An area with industry or other noise-generating activity, large volumes of traffic and high level of ambient noise. No sensitive disturbable receptors, such as holiday residences, schools and day care centers.

Magnitude of change

Very high ----	Noise levels caused by the activity are very high (exceed the planning guideline values very often at the nearest receptors). The use of the area may become impossible due to noise.
High ---	Noise levels caused by the activity are high (exceed the planning guideline values often at the nearest disturbable receptors). The sound insulation of residential buildings may need to be increased due to noise.
Moderate--	Noise levels caused by the activity are moderate (exceed the planning guideline values occasionally at the nearest disturbable receptors).
Low -	Noise levels caused by the activity are low (do not exceed the planning guideline values in any circumstances at the nearest disturbable receptors
No impact	The activity has no impact on the noise level.
Low +	Nr = not relevant
Moderate ++	Nr
High +++	Nr
Very high ++++	Nr

Underwater noise

Sensitivity of the receptor

Legislative steering, societal significance, susceptibility to change

Very high	A nature reserve where populations of marine animals that are sensitive to noise have been detected. A very large number of animals or animal species that are sensitive to

	noise and disturbable.
High	A nature reserve or other marine area free of ambient noise where marine animals that are sensitive to noise have been detected. A large number of animals or animal species that are sensitive to noise and disturbable.
Moderate	A normal marine area, with some marine animals sensitive to noise detected, moderate ambient noise level. Quite a large number of sensitive disturbable marine animals.
Low	An area with a lot of noise-generating activity, high volumes of waterborne traffic and a high level of ambient noise. Only few sensitive and disturbable marine animals (occasional individuals).

Magnitude of change

Very high ----	Noise levels caused by the activity are very high (exceed the biological dangerous zone very often). It may be impossible for marine animals to stay in the area due to noise.
High ---	Noise levels caused by the activity are high (exceed the biological dangerous zone often and mostly mask other noise, making the communication of marine animals difficult). It may be difficult for marine animals to stay in the area due to noise.
Moderate--	Noise levels caused by the activity are moderate (may mask other noise and make the communication of marine animals more difficult). The noise causes behavioral changes in marine animals.
Low -	Noise levels caused by the activity are low (do not cause significant behavioral changes in marine animals).
No impact	The activity has no impact on the noise level.
Low +	Nr = not relevant
Moderate ++	Nr
High +++	Nr
Very high ++++	Nr

3 VIBRATIONS

Sensitivity of the receptor

Legislative steering, societal significance, susceptibility to change

Very high	A lot of residences and/or holiday residences, no industrial activity, very low traffic volumes. No anthropogenic vibrations. A lot of sensitive or disturbable receptors in the scope of impact.
High	Residences and holiday residences, only little industrial activity, low volumes of traffic and low current vibration impacts. Quite a lot of sensitive or disturbable receptors in the scope of impact.
Moderate	Residences and some industrial activity, quite high volumes of traffic. Some disturbable or sensitive receptors in the scope of impact.
Low	Settlement that may have industrial activity, high volumes of traffic. No sensitive or disturbable receptors in the scope of impact

Magnitude of change

Very high ----	As regards blasting vibrations, peak particle velocities caused by the activity are very high (regularly or considerably exceed the guideline values set for buildings at disturbable or sensitive receptors). As regards traffic vibrations, the vibrations significantly disturb residents and are suspected to cause structural damage.
High ---	As regards blasting vibrations, peak particle velocities caused by the activity are high (often exceed the guideline values set for vibration

	impact on buildings at disturbable or sensitive receptors). As regards traffic vibrations, the vibrations occasionally disturb residents and may cause structural damage.
Moderate--	As regards blasting vibrations, peak particle velocities caused by the activity are moderate (may exceed the guideline values set for human amenity in literature at disturbable or sensitive receptors). Traffic vibrations occasionally observable but not disturbing.
Low -	As regards blasting vibrations, peak particle velocities caused by the activity are low (do not exceed the guideline values set for buildings or human amenity in literature at disturbable or sensitive receptors). As regards traffic vibrations, the impacts are targeted at unpopulated areas or the vibrations cannot be detected in residential buildings.
No impact	The activity does not cause vibrations.
Low +	Nr = not relevant
Moderate ++	Nr
High+	Nr
Very high +	Nr

4 HYDROLOGY AND WATER QUALITY

Sensitivity of the receptor

Legal protection, socio economic value, sensitivity

Very high ****	A number of Natura or protected areas are located within the impact area of the development. The impacted area includes a public beach of national or regional importance or some other use of water area of national or regional importance. The impacted area has very limited water exchange (current speeds < 2 cm/s). Water quality is very good (based on physical chemical indicators and chlorophyll).
High	The impacted area includes a Natura or protected area. The impacted area includes a public beach or some other use of water object. The impacted area has limited water exchange (current speeds 2-5 cm/s). Water quality is at least good (based on physical chemical indicators and chlorophyll).
Moderate	The impacted area includes a protected area or object. The impacted area includes a swimming location or some other public beach or water area. The impacted area has relatively good water exchange (current speeds 5-10 cm/s). Water quality is good (based on physical chemical indicators and chlorophyll).
Low *	The impacted area does not include any protected areas or objects. The impacted area does not include a swimming location or some other water use object The impacted area has good water exchange (current speeds > 10 cm/s). Water quality is poor or worse (based on physical chemical indicators and chlorophyll).

Magnitude of change

Very high negative impact	The development has significant impact on water quality and hydrology: - Model results show a clear increase in suspended sediments concentration by 20 times compared to the natural conditions - Model results show that a significant increase in suspended sediments concentration extends further than 10 km

	- The development results in a significant long-term (more than a year) increase in turbidity - A clear decrease in water quality (turbidity, nutrients, chlorophyll) - A high risk of contamination with hazardous substances - Very significant impact on near bottom currents.
High negative impact	The development has significant impact on water quality and hydrology: - Model results show an increase in suspended sediments concentration by 10-20 times compared to the natural conditions - Model results show that a significant increase in suspended sediments extends to an area of 3-10 km - The development results in a significant long-term (months) increase in turbidity - A clear decrease in water quality (turbidity, nutrients, chlorophyll) can be presumed - High risk of contamination with hazardous substances - Significant impact on near bottom currents.
Moderate negative impact	The development has moderate impact on water quality and hydrology: - Model results show an increase in suspended sediments concentration by 5-10 times compared to the natural conditions - Model results show that a significant increase in suspended sediments extends to an area of 1-3 km - The development results in a significant relatively short-term (weeks) increase in turbidity - A decrease in water quality (turbidity, nutrients, chlorophyll) can be presumed - There is a risk of contamination with hazardous substances - There is impact on near bottom currents.
Low negative impact	The development has insignificant impact on water quality and hydrology: - Model results show an increase in suspended sediments concentration by 2-5 times compared to the natural conditions - Model results show that a significant increase in suspended sediments extends to an area of < 1 km - The development results in a short-term (days) increase in turbidity - The decrease in water quality (turbidity, nutrients, chlorophyll) can be presumed to be insignificant - The risk of contamination with hazardous substances is low - The impact on near bottom currents is insignificant.
No impact	The development has no impact on water quality and hydrology.

5 BIRDS, FISH AND MARINE MAMMALS

Sensitivity of the receptor

Protection, endangering (threateness), renewability and recoverability

Very high ****	At least one I category protected species site is registered at the project area; or at least one such II category protected species site is registered at the project area that has less than 50% of sites protected from sites registered in environmental register; more than a half of the project area situates at the existing or planned protected area which is established among others also for protection of species from

	species group that is target of impact assessment. At the project area there exist nesting sites or habitats of such red listed species from species group that is target of impact assessment that are categorized into threat categories as endangered (EN) or stronger; more than a half of the project area is covered by a very representative threatened habitats; the area supports more than a common criterion of international importance of individuals of flyway population; at least three nationally important migration corridors of spatially active animal species cross project area or at least one nationally important site of protected species will be irreversibly damaged. Sites of I or II category protected species or representative habitats that are registered at the project area are not naturally renewable or recoverable with human help.
High ***	At least one such III category protected species site is registered at the project area that has less than 10% of sites protected from sites registered in environmental register; at least one third of the project area situates at the existing or planned protected area which is established among others also for protection of species from species group that is target of impact assessment. At the project area there exist nesting sites or habitats of such red listed species from species group that is target of impact assessment that are categorized into threat categories as vulnerable (VU) or near threatened (NT); at least one third of the project area is covered by a very representative threatened habitats; at least one nationally important migration corridors of spatially active animal species cross project area. Sites of protected species or representative habitats that are registered at the project area are not naturally renewable or recoverable with human help.
Moderate **	At least one III category protected species site is registered at the project area; at least 10% of the project area situates at the existing or planned protected area, which is established among others also for protection of species from species group that is target of impact assessment. At least 10% of the project area is covered by a representative habitats; at least three migration corridors of spatially active animal species cross project area. Sites of protected species or representative habitats that are registered at the project area are not naturally renewable or recoverable with human help.
Low *	There are no sites of protected species or other protected objects registered at the project area. There are no threatened species sites or representative habitats registered at the project area nor Birds Directive Annex 1 Red List species sites; no migration corridors of spatially active animal species cross project area. Sites of species and/or habitats that are registered at the project area are naturally renewable or well recoverable with human help.

Magnitude of change

Very high ----	As a result of the project, site of I category protected species will be destroyed; or at least one such II category protected species site will be destroyed that has less than 50% of sites protected from sites registered in environmental register.
High ---	As a result of the project, at least one II category protected species site will be destroyed; or at least one such III category protected species site will be destroyed that has less than 10% of sites protected

	from sites registered in environmental register; or nationally important representative habitat will be destroyed.
Moderate --	As a result of the project at least one III category protected species site will be destroyed; or representative habitat will be partly destroyed.
Low -	As a result of the project at least one protected species site will be destroyed; or representative habitat will be partly destroyed.
No impact	There will be no impact to protected species, habitats or other protected objects; there will be no impact to threatened species.
Low +	As a result of the project, situation of biodiversity, natural for the area (natural species richness, vitality of populations, structure of habitats), will be improved.
Moderate ++	As a result of the project, situation of the protected and/or threatened species and habitats (protected/threatened species richness, vitality of protected/threatened species populations, structure of protected/threatened habitats), will be improved.
High +++	As a result of the project, situation of the protected and/or threatened species and habitats (protected/threatened species richness, vitality of protected/threatened species populations, structure of protected/threatened habitats) and state of protection targets of the protected objects will be improved (decreasing endangering and increasing vitality).
Very high ++++	As a result of the project, situation of the protected and/or threatened species (certainly including also I and II category protected species) and habitats (protected species richness, vitality of protected species populations, structure of protected habitats) will be strongly improved and state of protection targets of the protected objects, will be improved (decreasing endangering and increasing vitality). As a result of the project overall value of the natural area will increase.

6 BIODIVERSITY

Sensitivity of the receptor

Protection, endangering (threateness), renewability and recoverability

Very high ****	At least one I category protected species site is registered at the project area; or at least one such II category protected species site is registered at the project area that has less than 50% of sites protected from sites registered in environmental register; more than a half of the project area situates at the existing or planned protected area which is established among others also for protection of species from species group that is target of impact assessment. At the project area there exist nesting sites or habitats of such red listed species from species group that is target of impact assessment that are categorized into threat categories as endangered (EN) or stronger; more than a half of the project area is covered by a very representative threatened habitats; at least three nationally important migration corridors of spatially active animal species cross project area or at least one nationally important site of protected species will be irreversibly damaged. Sites of I or II category protected species or representative habitats that are registered at the project area are not naturally renewable or recoverable with human help.
High ***	At least one such III category protected species site is registered at the project area that has less than 10% of sites protected from sites registered in environmental register; at least one third of the project area situates at the existing or planned protected area which is established among others also for protection of species from species

	group that is target of impact assessment. At the project area there exist nesting sites or habitats of such red listed species from species group that is target of impact assessment that are categorized into threat categories as vulnerable (VU) or near threatened (NT); at least one third of the project area is covered by a very representative threatened habitats; at least one nationally important migration corridors of spatially active animal species cross project area. Sites of protected species or representative habitats that are registered at the project area are not naturally renewable or recoverable with human help.
Moderate **	At least one III category protected species site is registered at the project area; at least 10% of the project area situates at the existing or planned protected area which is established among others also for protection of species from species group that is target of impact assessment. At least 10% of the project area is covered by a representative habitats; at least three migration corridors of spatially active animal species cross project area. Sites of protected species or representative habitats that are registered at the project area are not naturally renewable or recoverable with human help.
Low *	There are no sites of protected species or other protected objects registered at the project area. There are no threatened species sites or representative habitats registered at the project area; no migration corridors of spatially active animal species cross project area. Sites of species and/or habitats that are registered at the project area are naturally renewable or well recoverable with human help.

Magnitude of change

Very high ----	As a result of the project, site of I category protected species will be destroyed; or at least one such II category protected species site will be destroyed that has less than 50% of sites protected from sites registered in environmental register; or main protection target of the protected area existing at the project area will be destroyed.
High ---	As a result of the project, at least one II category protected species site will be destroyed; or at least one such III category protected species site will be destroyed that has less than 10% of sites protected from sites registered in environmental register; or one of the protection targets of the protected area existing at the project area will be destroyed; or nationally important representative habitat will be destroyed.
Moderate --	As a result of the project at least one III category protected species site will be destroyed; or other protected object will be partly destroyed; or representative habitat will be partly destroyed.
Low -	As a result of the project at least one protected species site will be destroyed; or other protected object will be partly destroyed; or representative habitat will be partly destroyed.
No impact	There will be no impact to protected species, habitats or other protected objects; there will be no impact to threatened species.
Low +	As a result of the project, situation of biodiversity, natural for the area (natural species richness, vitality of populations, structure of habitats), will be improved.
Moderate ++	As a result of the project, situation of the protected and/or threatened species and habitats (protected/threatened species richness, vitality of protected/threatened species populations, structure of protected/threatened habitats), will be improved.

High +++	As a result of the project, situation of the protected and/or threatened species and habitats (protected/threatened species richness, vitality of protected/threatened species populations, structure of protected/threatened habitats) and state of protection targets of the protected objects will be improved (decreasing endangering and increasing vitality).
Very high ++++	As a result of the project, situation of the protected and/or threatened species (certainly including also I and II category protected species) and habitats (protected species richness, vitality of protected species populations, structure of protected habitats) will be strongly improved and state of protection targets of the protected objects, will be improved (decreasing endangering and increasing vitality). As a result of the project overall value of protected objects will increase.

7 SETTLEMENT STRUCTURE, BUILT ENVIRONMENT, PLANNINGS AND LAND USE

Sensitivity of the receptor

Very high - - - -	Existing settlement structure and land use in the area will change thoroughly as a result of the project. The project has significant negative impact on the development and land use of the area. It may be necessary to demolish existing and functioning buildings. The project is in conflict with development aims / defined land use functions (including adopted detailed plans) prescribed in land use plans and development plans. The project is in conflict with settlement and land use aims defined in national plans, and with national strategic aims.
High - - -	Existing settlement structure and land use in the area will change significantly as a result of the project. The project has high negative impact on the development and land use of the area. The project is in conflict with the aims established for land use and constructed environment in existing development plans and local plans, and may contain a proposal for changing the established comprehensive plan with regard to land use / declaration of invalidity of a detailed plan. The project changes or specifies existing national land use aims, which are reflected in the national plan or county plan.
Moderate - -	Existing settlement structure and land use in the area will change partly as a result of the project. The impact is moderate and does not interfere with other developments in the area. The project may be in conflict with the aims established for land use and constructed environment in existing development plans and local plans, but may contain a proposal for changing the established comprehensive or detailed plan with regard to land use. The project corresponds to main national land use aims. The project specifies existing national land use aims, which are reflected in the national plan or county plan.

Small -	Existing settlement structure and land use in the area will to a small extent as a result of the project. The project may be in conflict with the aims established for land use and constructed environment in existing development plans and local plans, but may contain a proposal for changing the established comprehensive or detailed plan with regard to land use. The project corresponds to main national land use aims. The project specifies national aims or corresponds to existing national land use aims, which are reflected in the national plan or county plan.
No impact	The project does not cause significant changes the development and land use of the area. There is no significant negative or positive impact. The project corresponds to the aims set for land use and constructed environment in existing development plans and plans of various levels. There are no proposals for changing existing plans. The project corresponds to main national land use aims.
Small +	The project has small positive impact on the development and land use of the area. The project does not interfere with other land use plans in the area. The project corresponds to the aims set for land use and constructed environment in existing development plans and plans of various levels. The project corresponds to main national land use aims, and enables their enactment.
Moderate + +	The project has moderate positive impact on the development and land use of the area. The project provides functional input to existing settlement structure and land use in the area. The project corresponds to and supports the aims set for land use and constructed environment in existing development plans and plans of various levels. The project corresponds to main national land use aims, and enables their enactment.
High + + +	The project has significant positive impact on the development and land use of the area. The project provides functional input to existing base structure and land use in the area. The project corresponds to and supports the aims set for land use and constructed environment in existing development plans and plans of various levels. The project corresponds to main national land use aims and enables their enactment or even expedites achieving the aims.
Very high	The project has very positive impact on the development of the area.

+ + + +	The project diversifies supports and provides functional input to existing settlement structure and land use in the area. The project enables the creation of new jobs and business opportunities. The project corresponds to and supports the aims set for land use and constructed environment in existing development plans and plans of various levels. The project achieves the aims established for land use and settlement structure in the national plan.

Magnitude of change

Very high * * * *	Extent of impact is national (or even international).
High * * *	The impact extends 10-100 km from the project area.
Moderate * *	The impact extends 1-10km from the project area.
Small *	The impact only extends to the immediate vicinity of the project area under 1 km.

Duration of impact

Very high * * * *	Changes in the environment occur during construction as well as operation. The impact is either very long-term or permanent. The impact is evident during a long period and continuous.
High * * *	Changes in the environment occur during construction but after a number of years, the environment will restore. The impact is long-term but not necessarily permanent or if it is permanent then it is not noticeable.
Moderate * *	Changes in the environment occur during construction but after a couple of years, the environment will restore. The impact is short-term, disturbing factors are not permanent.
Small *	Changes in the environment only occur during construction, and are evident to a small extent during operation. Disturbing impact is not permanent.

Sensitivity of the receptor

Legal protection, socio economic value, sensitivity

Very high	The impacted area includes protected or valuable area or heritage conservation area. The area or its vicinity includes a significantly impacted residential area. The construction involves creating a building of national importance or an object of high spatial impact. The land use conditions of the area are established with a national or county plan, and are in conflict with the assessed project.
High	Area of natural or cultural value, tourist area, or recreational area. The project may have partial impact on residential areas.

	Creation area with regionally important function (public area, agricultural area of regional importance, recreational area etc.) or an object with significant spatial impact. The land use conditions of the area are established with a general plan, and are in direct or partial conflict with the assessed project.
Moderate	Low-density area, profit-yielding land, area of other land use, no significant land use conflicts between the assessed project and land use. Area of important functionality on the local level (e.g. valuable agricultural land, residential area of complete social setting, public area, including recreational land etc.). The land use conditions of the area are established by a comprehensive plan or a detailed plan or there is no valid comprehensive or detailed plan for the area. The land use aims correspond to the strategic aims of more general plans.
Small	Industrial area or low-density profit yielding land with no significant value. No conflict between existing and planned land use, and the project. The area has no value with regard to society. The project has no significant impact on land use on local level. The land use conditions of the area are established by a comprehensive plan or a detailed plan, which corresponds to the project. The project corresponds to the aims established in national development documents.

APPENDIX 5 SUMMARY OF THE EIA REPORT FOR FINLAND

SUMMARY OF THE FINNISH EIA REPORT

The environmental impact assessment (EIA) procedure for the Balticconnector project has been conducted in Finland and in Estonia in compliance with national legislation. The procedure has involved the production of separate environmental impact assessment reports (EIA reports) in both countries.

This summary is a brief description of the project's alternatives and main impacts in Finland. The full Finnish EIA report is available on the Gasum website in Finnish, English and Swedish (*http://www.balticconnector.fi*).

The contents of the Finnish EIA report by chapter are shown in the table below.

EIA report chapter	Chapter contents in brief
1. **Project**	The purpose of the chapter is to present the project. A brief description of the Project Developers, their business activities and position from the project perspective as well as backgrounds and purpose of the project is provided. The chapter also presents the project schedule and the relationship of the project with other projects. The chapter covers the previously studied routing alternatives, the selection of the current route, and the alternatives assessed in the EIA procedure.
2. **Environmental impact assessment procedure**	The chapter describes the EIA procedures carried out for Finland as well as Estonia taking the requirements of international consultations and the bilateral agreement The aim of the law concerning the environmental impact assessment procedure (EIA procedure) in Finland is to promote the assessment of environmental impacts and take them into account in a uniform way in planning and decision-making. At the same time, the goal is to increase the information received by citizens and promote their opportunities to participate. The purpose of the EIA procedure is to ensure that the environmental impacts of a planned project are investigated with sufficient precision before decision-making.
3. **Technical description of the project**	The chapter describes the phases, procedures and technical data relating to project design, construction and operation.
4. **Licenses, permits, plans and decisions required for the project**	The licenses, permits, plans and decisions required for the project are described in the chapter.
5. **Project's relationship with programs concerning the use of natural resources and environmental protection**	The chapter presents the key plans and programs concerning the use of natural resources and environmental protection, including national target programs as well as international commitments, from the project's perspective.

6. **Starting points of the environmental impact assessment**	The chapter describes the starting points of the EIA and covers the scoping, significance and extent of the environmental impacts in general. In the assessment work, the multi-criteria decision analysis (MCDA) practices and tools developed in the EU LIFE+ IMPERIA project (presented in chapter 6) were employed as appropriate in the assessment of the significance of the environmental impacts.
7. **Current state of the environment**	The chapter describes the current state of the environment as regards the Gulf of Finland and Inkoo, Finland.
8. **Assessment methods and the environmental impacts assessed**	The chapter presents the assessment methods employed in the assessment and the uncertainties relating to the assessments conducted. The chapter also presents the results if the impact assessment by environmental impact, including the impacts of the zero alternative, cumulative impacts with other known projects, impacts of project decommissioning and transboundary effects. A summary of the significance of the impacts and comparison between alternatives is also provided in conjunction with assessment results. The chapter further describes the means and ways that can be employed by the Project Developers in subsequent project phases to prevent or mitigate any adverse impacts caused by the project and assessed in the EIA report.
9. **Comparison between alternatives**	The chapter describes the principles, phases and results of the comparison carried out between the alternatives. The chapter aims to also provide the reader with a clear idea of the feasibility of the alternatives and of how the comparison between the alternatives was carried out and what its results are based on.
10. **Environmental impact monitoring**	The chapter describes the plans made by the Project Developers for environmental impact monitoring during and after the project.

Application and stages of the EIA procedure

The offshore natural gas pipeline will enable the transmission of natural gas between Finland and Estonia. Due to the international dimension of the Balticconnector project, two main international procedures are applied to the project: the UNECE Convention on Environmental Impact Assessment in Transboundary Context (Espoo Convention) and the bilateral Agreement between Finland and Estonia on Environmental Impact Assessment in a Transboundary Context.

Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment was enforced in Finland pursuant to Annex 20 to the Agreement creating the European Economic Area under the Act on the Environmental Impact Assessment Procedure (468/1994) and the Decree on the Environmental Impact Assessment Procedure (713/2006). The EIA Act is in force in the Finnish Exclusive Economic Zone referred to in section 1 of the Act on the Finnish Exclusive Economic Zone (1058/2004).

The Balticconnector project is not included in the list of projects given in section 6 of the EIA Decree under subsection 8 b of which the EIA procedure is applied to gas pipelines with a diameter of more than DN 800 mm and a length of more than 40 km. Under section 4(2) of the EIA Act, the assessment procedure is also applied in individual cases to a project other than one referred to in the list of projects that will probably have significant adverse environmental impact comparable in type and extent to that of the projects included in the list.

Pursuant to decision YM1/5521/2006 issued on February 17, 2006 by the Ministry of the Environment, the environmental impact assessment procedure is applied to the Balticconnector natural gas pipeline project. The Balticconnector natural gas pipeline will have a diameter of approximately DN 500 mm and total approximately 80 km in length, which may be assumed to be likely to have similar environmental impacts as gas pipelines included in the list of projects provided in section 6 of the EIA Decree (diameter DN 800 mm, length 40 km). The project is also covered by section 8 of the list of projects provided in Appendix 1 to the bilateral agreement on EIA between Finland and Estonia (large-diameter oil and gas pipelines, underwater pipelines in the Baltic Sea).

The aim of the environmental impact assessment procedure in Finland is to promote the assessment of environmental impacts and take them into account in a uniform way in planning and decision-making. At the same time, the goal is to increase the information received by citizens and promote their opportunities to participate. The purpose of the EIA procedure is to ensure that the environmental impacts of a planned project are investigated with sufficient precision before decision-making.

The EIA procedure for Finland comprises two stages. Firstly, an environmental impact assessment program was prepared. This is a plan specifying which impacts will be assessed and how they will be assessed. The Project Developer submitted the EIA program to the coordinating authority, the Uusimaa Centre for Economic Development, Transport and the Environment, on January 27, 2014. The coordinating authority gave notification of the public display of the EIA program in media including local newspapers and its website. The EIA program was on display for statements and opinions between February 10 and April 7, 2014. The coordinating authority made a summary of opinions and statements provided and issued its own statement regarding the program on May 7, 2014.

The report concerning the project's environmental impacts – the EIA report – was produced in the second stage of the EIA procedure. The EIA report was prepared on the basis of the EIA program and the opinions and statements provided concerning the program. Investigations for this EIA report commenced in spring 2014, and the report was submitted to the coordinating authority in April 2015. The work was guided by the statements and opinions received during the program stage as well as comments provided at public consultations. The contents of the EIA report were also affected by the comments on the draft report made by the EIA monitoring group.

Citizens and various stakeholders may express their opinion about the EIA Report within the period of time specified by the coordinating authority. The EIA procedure ends in Finland when the coordinating authority provides its statement on the EIA Report. The EIA report as well as the stakeholder interaction carried out and the material acquired during the EIA procedure will provide important support to more specific planning and design concerning the project in Finland.

Alternatives assessed in Finland

In addition to the entire pipeline route, the following alternatives were examined in the environmental impact assessments conducted (Figure 0-1) in Finland:

Alternative FIN 1 (ALT FIN 1): Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Inkoo, Finland, to Paldiski, Estonia, route north of Stora Fagerö.

Alternative FIN 2 (ALT FIN 2): Construction of the Balticconnector natural gas pipeline across the Gulf of Finland from Inkoo, Finland, to Paldiski, Estonia, route south of Stora Fagerö.

In addition, two alternative points of landfall in Finland and the respective natural gas pipeline routings in Inkoo were examined:

Landfall 1 (LF1): Landfall of the Balticconnector natural gas pipeline north of the Fjusö Peninsula in the Bastubackaviken Bay area.

Landfall 2 (LF2): Landfall of the Balticconnector natural gas pipeline on the Fjusö Peninsula.

A situation where the Balticconnector natural gas pipeline will not be constructed was assessed as the zero alternative.

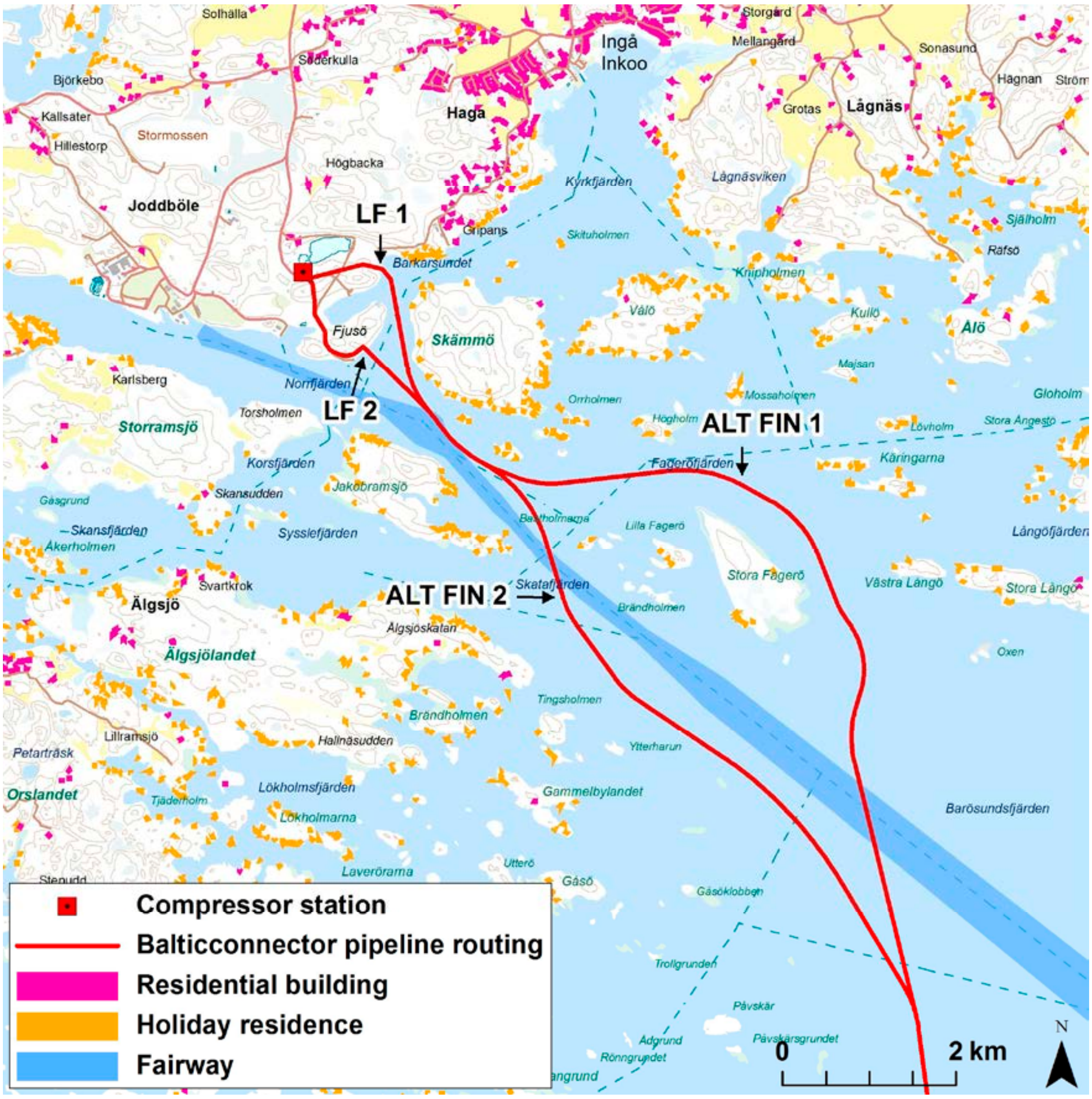

Figure 0-1. The routing alternatives of the Balticconnector natural gas pipeline in Finland.

The ALT FIN 1 alternative passes the island of Stora Fagerö from the north and the east and crosses the fairway southeast of Stora Fagerö at a point where the fairway is wide and relatively deep. The ALT FIN 2 alternative crosses the fairway west of Stora Fagerö closer to the Port of Inkoo and runs between Stora Fagerö and Älgsjö towards the south.

After crossing the fairway, ALT FIN 2 runs parallel to the fairway for several kilometers. Water depth at the intersection of the fairway and the natural gas pipeline route alternatives (ALT FIN 1 and ALT FIN 2) is approximately 23–30 m. ALT FIN 1 is around 1.3 kilometres longer than ALT FIN 2. The routes come together before passing west of the Hästen lighthouse. From there the route runs into the deeper parts of the outer archipelago towards Estonia, passing the Enoksgrund shallow from the east.

The landfall alternatives (LF1 and LF2) are located in Inkoo north of the Fjusö Peninsula in the Bastubackaviken area and on the Fjusö Peninsula around two kilometres northeast and east of the Port of Inkoo, in north of theInkoo sea lane. The landfalls and underground natural gas pipeline routings as well as areas directly connected with them are mostly fenced off. The fenced area relates to the activities of the National Emergency Supply Agency, and access to the area is restricted. The area is not currently used for residential or holiday accommodation, recreation or other public or private access. The area is mostly covered by forest.

Sensitive sites in the vicinity of the pipeline route and the alternatives have been determined during the environmental impact assessment (Figure 0-2 and Figure 0-3).

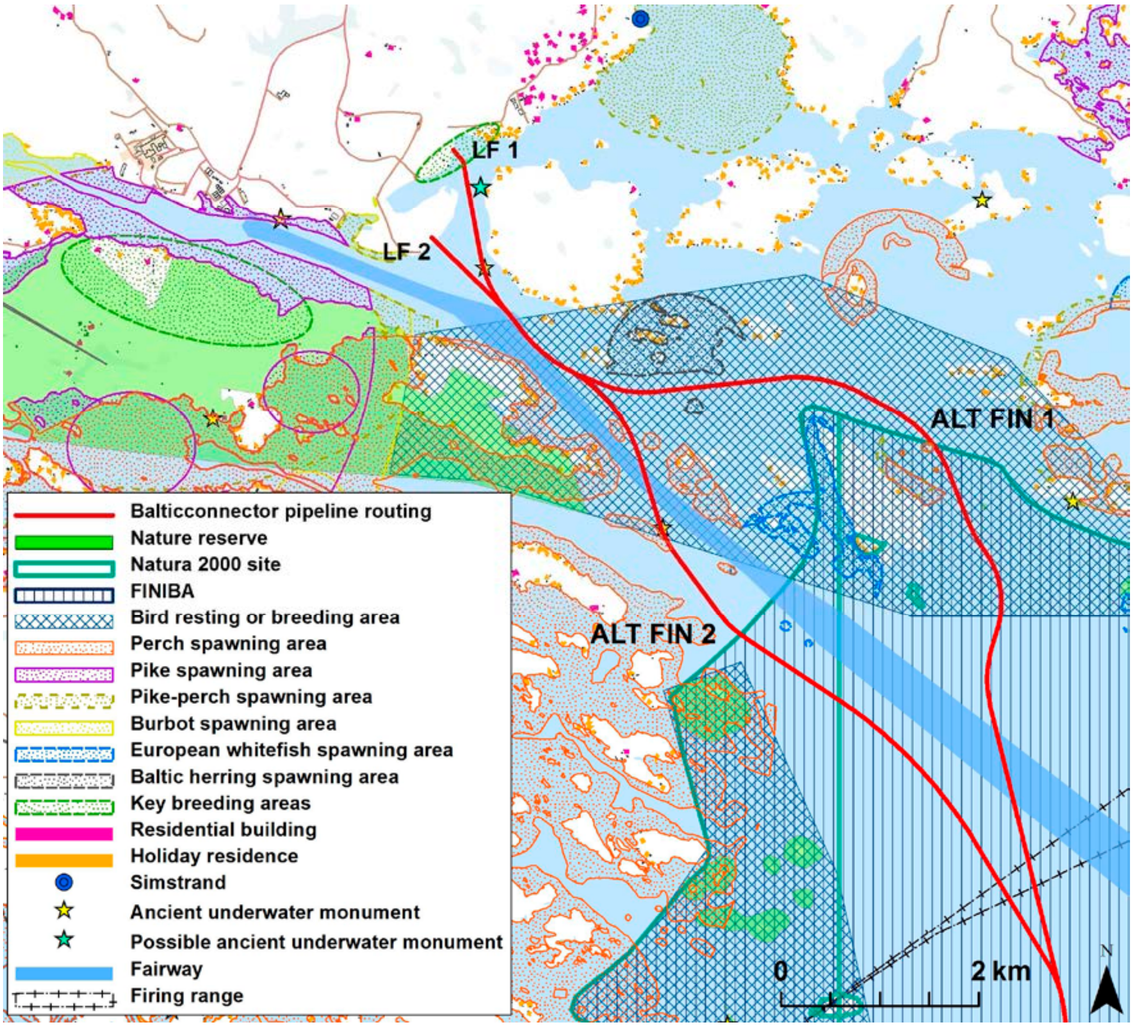

Figure 0-2. Sensitive sites in the vicinity of the pipeline route alternatives in Inkoo coastal area.

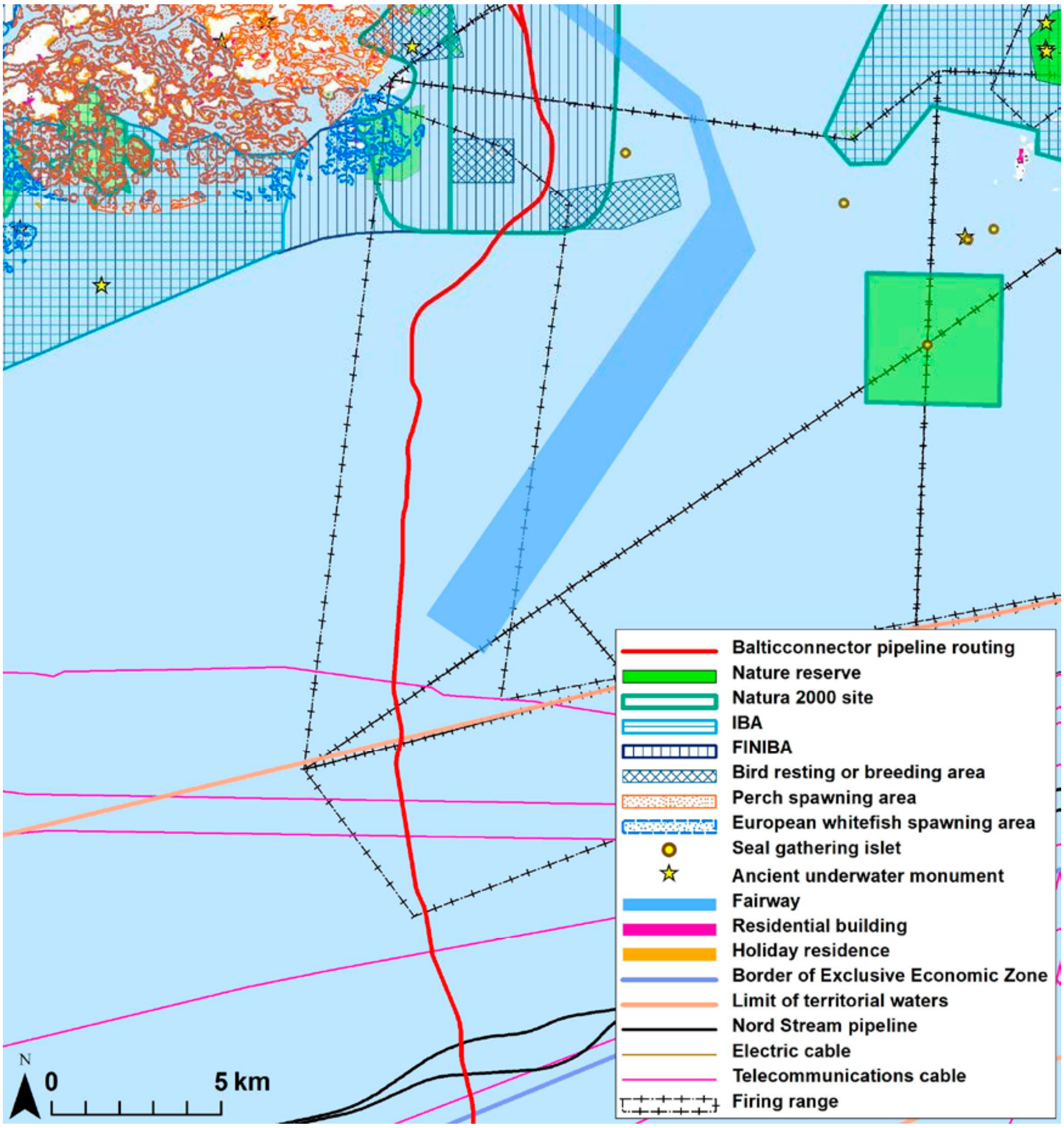

Figure 0-3. Sensitive sites in the vicinity of the pipeline route in the open sea area.

The most significant environmental impacts

The most significant environmental impacts of the project will arise during the construction of the natural gas pipeline. Adverse impacts during pipeline operation will be of lower significance. Impacts identified as the most significant impacts during construction are impacts on seabed, water quality, the marine environment, flora and fauna.

According to preliminary calculations and plans, a significant amount of seabed intervention measures (dredging, ploughing or jetting, underwater blasting and subsea rock installation) will be required for pipeline protection and freespan rectification. The actual need for seabed intervention will be specified further once progress is made in technical project design, with the need for intervention for each pipeline section likely to be reduced below the level presented in this EIA report. The environmental impact assessments conducted are based on conservative assessments concerning project measures, and efforts have been made to conduct them on the basis of the worst-case scenarios.

Impacts during construction

Offshore areas

For the purpose of environmental impact assessment, the suspended solids load caused by natural gas pipeline construction work was modeled using a mathematical model on water movements and the migration of substances. The amount of seabed intervention required during construction will be relatively small in the offshore areas of western Gulf of Finland, with the impacts on water quality in these areas being very low due to the large volumes of water, efficient exchange of water and lesser nature values. The affected area is estimated to extend approximately to a maximum of 1 km from the pipeline. Turbidity and accumulation areas as well as impacts on marine environment will be clearly lower than in near-shore areas. Harmful substances are likely to be dispersed with suspended matter along the flow directions but to be ultimately resedimented with the solids.

Impacts on water bodies were also found to be temporary, local and low in the environmental monitoring carried out during the construction of the Nord Stream gas pipeline project. In offshore areas the duration of noise and other disturbances will also be shorter than in archipelago areas as construction work will progress faster further off the shore.

Where permitted by the ice situation, some birds, seals and occasionally also harbor porpoises are found in the open sea areas of the Gulf of Finland. No particularly important feeding areas attracting large numbers of individuals are known in the area covered by the natural gas pipeline project. Among birds, Anseriformes in particular prefer feeding in shallow areas very rarely found in open sea areas. The impacts of offshore turbidity on bird fauna are likely to be low as the impacts on fish, bivalves and other small fauna that they feed on are estimated to be very local and short-term. Deep-bottom zoobenthos will be destroyed almost all the way underneath the pipeline, but on the whole the natural gas pipeline is not estimated to pose a major risk to offshore soft-bottom benthic communities which, due to the poor oxygen situation, are quite non-diverse and have good recovery potential.

Fish populations are impacted particularly by underwater explosions, which result in behavioral changes over several kilometers and risk of injury up to hundreds of meters from the blasting site. Demersal fish are also affected by changes in the benthos, which may have either negative or positive impacts depending on the species of fish. No significant fish spawning areas can be found in the offshore zone of the project area. The impact on fisheries is reduced by the fact that the impact focus will be on mature fish.

Adverse effects on fishing in the offshore areas of the Gulf of Finland will mainly be caused by the prevention of trawling in the project area during construction. Fishing vessels operating in the area will be disturbed by increased vessel traffic, seabed intervention work, pipelaying as well as pipeline protection measures. In the Gulf of Finland however, where fairway crossings take place in the open sea, the impacts on other vessel traffic will be low as there will be plenty of space around the safety zone of the pipelaying vessel for diversionary routes, resulting in only short detours.

The risks relating to the construction of the natural gas pipeline are low. The most significant risks comprise the collision of installation vessels participating in pipelaying with other vessels as well as any munitions and barrels containing hazardous substances found in the seabed in the construction area. The prevention of safety incidents is the primary goal set for planning. Planning will take place in compliance with legislation as well as safety and occupational health and safety rules. Efforts will be made to prevent vessel collisions and groundings through traffic control. The disposal of munitions and barrels will be negotiated with the relevant national authorities.

Coastal areas

According to assessments made on the basis of the results of water system modeling carried out off Inkoo, turbidity caused by the various phases in the construction of the natural gas pipeline will be relatively low. The biggest impacts will be seen near the coast where flow rates are lower and turnover of water slower than in offshore areas. Ploughing is the method causing the highest levels of turbidity. Changes in wind direction will create a potential impact area around the construction site, the extent of which as well as the dispersal direction of turbidity will vary depending on the wind and flow situation. The division of the work into stages will result in repeated turbidity bursts varying in locations occurring throughout the construction period. Sludge accumulation will increase during the work but will remain small in quantity due to the short duration.

According to preliminary construction method plans, blasting through explosions will take place in several locations. An explosion generates a rapid increase in pressure, a blast, which is followed by a rapid decrease in pressure. The turbidity cloud created moves with currents. The material is mostly minerals, whereby it will settle quite quickly. Due to their very brief duration, the water quality impacts of turbidity clouds are assessed to be low in comparison with impacts including those of dredging and ploughing. The impacts of blasts are the highest on aquatic organisms.

Sediment mixing may result in the release of pollutants into sea water, and these may end up in body systems of animals and in food chains. According to the results of sediment sampling, however, the concentrations of metals and organic compounds are low, however, and remain below the reference values determined on the basis of ecological criteria. Pollutants will be dispersed with turbidity but are likely to be eventually resedimented with the solids.

Birds nesting on islets near the pipeline alternatives may experience significant temporary disturbance to food sourcing if turbidity is high and occurs during their breeding season. Overall the impact is, however, assessed as low because the turbidity will be short-term and only take place in a small area at a time. As regards fish, significant impacts during construction were assessed to occur in situations where there are adverse effects on fish spawning areas, spawning or fry. In these respects the most significant impacts will be targeted at the inner archipelago (spring-spawning fish species, possibly some species seeking to spawn in rivers) as well as middle and outer archipelago (Baltic herring, *Clupea harengus membras*, and the sea-spawning lavaret, *Coregonus l. widegreni*) of Inkoo. The adverse effect caused by the deterred fish will be temporary and can be addressed through compensations to commercial fishers. Any impacts on fish breeding areas will, however, result in permanent adverse effects.

Vessel traffic during the construction of the Balticconnector pipeline will contribute to the impacts of vessel traffic near the islands by the pipeline and the areas close to the Inkoo fairway. Bird populations in the archipelago of the Stora Fagerö area in particular will be subjected to the impacts of noise and other disturbances as the planned routing alternatives run close to nesting islets. The impacts of above-water noise on birds will, however, overall be low. Any damaging impact of underwater noise is likely to affect a small number of individuals (such as birds, harbor porpoises and seals), and therefore the impacts of underwater noise are also assessed as low concerning animals in the area. In the worst cases, however, underwater noise may injure individual marine mammals. Therefore measures mitigating the impacts of pressure waves must be employed in blasting to prevent injuries in marine mammals.

Vessel transport during construction involves the regular vessel transport risks, such as the risk of oil spill or introduction of non-indigenous species. The risk of introduction of non-indigenous species is low in conjunction with the project as transport takes place locally. Vessel traffic also causes nitrogen oxide, sulfur dioxide, particulate and carbon dioxide emissions, but their impact in the project will be low in comparison with other waterborne transport. Considering the volumes transported by the vessels, the impacts of increased vessel traffic are estimated to be low on the whole.

The impacts on people and society will focus almost entirely on the period of natural gas pipeline construction. The adverse effects caused by the construction of the natural gas pipeline will, however, be non-persistent by nature, whereby their impact will not last for a long time. Compared with the current situation, some work conducted during construction may to some extent cause annoyance. Human perception of adverse effects or their impacts on amenity and living conditions depends on the individual. The most significant impacts will be related to temporary noise disturbance in marine and land areas and increases in vessel traffic during construction. Short-term turbidity in water areas close to the offshore pipeline may cause minor adverse effects on the recreational use of the areas during construction.

Impacts during operation

The Balticconnector natural gas pipeline will cover a strip of the seabed in the Gulf of Finland. The pipeline and the subsea rock installations protecting it will form a protrusion from the seabed in many places. In normal situations there will be no impact on water quality during the operation of the natural gas pipeline. During operation, the impacts of the pipeline on the marine environment will mainly be restricted to minor flow amendments due to morphometric changes caused by the pipeline itself and its construction (covering and protection) in areas near the pipeline, such as increased turbulence around the pipeline at faster bottom flow velocities. Changes in flow velocities and directions may affect the transport and accumulation of materials in the close vicinity of the pipeline. According to measurements carried out for the Nord Stream project, the impacts only extend up to tens of meters from the pipeline.

The overall impacts during the operation of the natural gas pipeline in the archipelago and sea area will be low. Periodic inspections and servicing and maintenance tasks may cause minor disturbances to birds and marine mammals, but these will not differ from the disturbance caused by other movement in the area. Pipeline maintenance measures will include the addition of soil around the pipeline wherever necessary. Such measures may contribute toward changes in near-bottom flows as well, whereby changes in flows may cause changes in erosion or sediment accumulation in nearby areas.

Flora in the onshore gas pipeline work area will be allowed to restore naturally following pipeline construction. An area along the line of the pipe that is approximately 5 m in width will be kept treeless and cleared of shrubbery. Impacts during operation on flora and fauna will be restricted to the cleared zone and areas near it, with changes taking place in species composition from the current situation. An increase in flora such as grasses and sedges and a decrease in herb-rich forest plants are likely to be seen in the cleared zone. The edge effect will not extend very far into the environment, and the zone that is kept clear of trees and shrubbery will not restrict the movement of animals or cause significant habitat changes for breeding birds.

The compressor station may be fueled by electricity or natural gas. If fueled by electricity, there will be no local flue gas emissions from the compressor station. A natural gas-fueled compressor station will generate small amounts of carbon dioxide (CO_2), nitrogen oxides (NO_x) and water vapor. The combustion of natural gas does not result in any sulfur dioxide of particulate emissions. According to calculation results, noise impacts during compressor station operation will be low and very local.

Possible damage to the gas pipeline and resulting pipeline malfunction could have consequences to human safety. The risk assessment conducted for the Balticconnector project (*Ramboll 2014b*) identified the sections where the pipeline must be protected to prevent pipeline damage Maintenance management of the natural gas pipeline will be carried out to ensure the pipeline will be kept in good working order and will not face an external risk (with the biggest risk being mechanical pipeline damage caused by an outsider).

<u>Transboundary impacts across the borders of Finland</u>

The Balticconnector project is not estimated to cause significant transboundary impacts across the borders of Finland. The pipeline will extend across western Gulf of Finland to Estonia, whereby construction work in Finnish waters may result in low impacts in Estonia’s territorial waters. No impacts are estimated to occur on other Baltic states.

The deterioration of water quality arising from seabed interventions relating to the construction of the natural gas pipeline will be restricted in terms of area and duration. Offshore impacts on western Gulf of Finland will be low due to the large volumes of water and, on the other hand, the smaller scale of the marine works carried out. Due to the large water depth and the stratification of the water column in this area, the impacts will not in practice reach the surface layer. According to preliminary plans, there will be low levels of construction carried out in Finland’s Exclusive Economic Zone (EEZ) south of KP 34. The marine works carried out in Finland’s EEZ and turbidity arising from these will not cause any significant adverse effects in Estonian EEZ or territorial waters. The contaminant contents found in sediment samples obtained from the Balticconnector pipeline route were also low, and their distribution with solids during construction is not likely to pose a risk to the marine environment in Estonian EEZ or territorial waters. The Balticconnector project will not have significant transboundary impacts on water quality regardless of whether construction is carried out in Finnish or Estonian waters. Any low impacts taking place will be short-term and local.

Gas pipeline project activities taking place within Finnish waters during construction or operation are not estimated to have significant transboundary impacts on flora, birds, marine mammals or fish in Estonian waters either. Underwater blasting causes brief and high levels of sound pressure transported over distances of tens of kilometers. Underwater blasting will take place in Finnish as well as Estonian waters. The number of blasting sites will, however, be higher on the Finnish side. The nearest blasting site is located around 3 km from the border of Estonia's EEZ. As the distance from the blasting site increases, the impacts are reduced as the intensity of the sound decreases. Underwater noise from seabed dredging and possible blasting explosions may be carried from Finnish waters to Estonian waters, whereby seals or harbor porpoises in the area may hear sounds caused by blasts. Due to the distance, however, there will not be significant noise impacts on the behavior of marine mammals. Above-water noise impacts will be low and short-term, and no significant transboundary impacts across the Finnish borders are estimated to occur during project construction or operation.

The nearest Natura 2000 site in Finland's neighboring states is Naissaare, Estonia (EE0010127, SCI), located around 30 km from the limit of Finland's territorial waters. Balticconnector project activities on the Finnish side will not result in impacts on the protection principles of the Natura site.

Seabed intervention will mainly result in momentary local impacts on other vessel traffic with a maximum duration of few days for each area. In the offshore areas between Finland and Estonia where the pipeline will cross busy fairways, the safety zone will result in impacts on other vessel traffic as the diversion of the safety zone of the installation vessel will required. This is not estimated to have a significant impact on the safety of vessel traffic considering the existing navigation and traffic control measures. Emissions from the vessels participating in pipelaying will have an impact on air quality in the Estonian territory when the vessels are close to the Estonian territory. The impacts will be very low and remain close to the route taken by the vessels.

The transboundary impacts of the project on people and society will be low. There will be a temporary increase in technological and economic activity in Estonia and well as Finland during construction. During operation, there will be an emphasis in transboundary impacts on the territory of the two states on the role of the natural gas pipeline as an energy transport channel reducing dependency on Russian natural gas supply. The Balticconnector pipeline will not cause restrictions on bottom trawling, whereby there will be no impact on those who work in fisheries.

In the possible worst-case scenario accident in Finnish waters (gas pipeline rupture), the size of the dangerous flammable gas cloud would be slightly over 700 m, whereby the impact would also extend to waters on the Estonian side.

Feasibility of alternatives and summary of comparison

As regards environmental impacts, the alternatives examined are feasible when a special focus in project design is placed on the prevention and mitigation of adverse impacts from construction. No adverse environmental impacts that are unacceptable or that could not be mitigated to an acceptable level were found during the environmental impact assessments of the project alternatives. The overall significance of the implementation alternatives assessed is shown in the table below (Table 0-1).

Due to the higher levels of solids resulting from construction, the impacts on water quality, marine environment, fish, fisheries, and birds will be higher in the ALT FIN 1 alternative than in ALT FIN 2. The ALT FIN 1 routing alternative is also closer to its natural state and more susceptible to changes, and more commercial fishing is carried out in its vicinity than that of the ALT FIN 2 alternative. The ALT FIN 1 alternative is also closer to significant bird areas and a nesting ground of a species under strict protection than ALT FIN 2. Water quality impacts during construction will be larger with LF1 than LF2 due to higher solids concentration. The adverse effects on fish and fisheries caused by LF1 will be larger than those of LF2 due to the destruction of a significant reedbed area. The magnitude of adverse effect on commercial fishing will also be greater and the affected area larger than with LF2.

The route taken by ALT FIN 2 east of Jakobramsjö passes closer to holiday residences than ALT FIN 1, whereby ALT FIN 2 may affect the recreational conditions of a larger number of holiday residents. LF1 is closer to holiday and permanent residences than LF2, whereby temporary adverse effects may be caused at a slightly higher level on the amenity of coastal residents and swimming beach users. Human perception of adverse effects or their impacts on amenity and living conditions depends on the individual. The noise impacts of LF1 regarding the landfall site and onshore blasting would be slightly higher than those of LF2. LF1 may result in the daily guideline value of 45 dB(A) being exceeded over the short term by the nearest holiday residences. Furthermore, in the event of the possible (but highly unlikely) leak from the natural gas pipeline, there are more holiday residences in the danger zone of the LF1 alternative near Inkoo than there are in the LF2 alternative. None of the adverse effects are assessed to result in a permanent change in the living conditions of local residents or holiday residents. Landfall LF1 is located on a site in accordance with the local detailed plan unlike LF2. On the other hand, changes to the detailed plan are likely to be required in any case.

In addition to adverse impacts, the implementation of the project will also have positive environmental impacts. The long-term objective of the development of the Finnish energy market is to increase natural gas sourcing alternatives to ensure supply security and the functioning of the natural gas market. At the moment natural gas for Finland is only sourced from Russia. The construction of the LNG terminal and the Balticconnector natural gas pipeline would contribute to the development of the natural gas market and supply security in Finland. The positive impacts on employment and livelihoods will also not be realized if the project is not implemented. If the project is not implemented, neither the adverse nor the positive impacts of the project will be realized.

Table 0-1. Assessment scale for the assessment of the significance of impacts and the significance of the environmental impacts of the implementation alternatives of the Balticconnector project assessed (ALT FIN 1, ALT FIN 2, LF1 and LF2) in comparison with the current situation and the non-implementation of the project (zero alternative).

Significance of impacts	Very high ++++
	High +++
	Moderate ++
	Low +
	No impact (0)
	Low -
	Moderate --
	High ---
	Very high ----

PROJECT'S ENVIRONMENTAL IMPACTS	ALT 0	CONSTRUCTION				OPERATION			
		ALT FIN 1	ALT FIN 2	LF1	LF2	ALT FIN 1	ALT FIN 2	LF1	LF2
Seabed	0	–	–	–	–	–	–	–	–
Water quality	0	– –	– –	– –	– –	–	–	–	–
Benthic fauna and aquatic flora	0	–	–	– –	–	–	–	–	–
Fish fauna	0	– –	– –	– – –	– –	–	–	–	–
Fishing	0	– –	– –	– – –	– –	0	0	0	0
Conservation areas	0	– –	– –	–	–	0	0	0	0
Flora	0	–	–	–	–	–	–	–	–
Bird fauna	0	– –	– –	–	–	0	0	0	0
Other fauna	0	–	–	–	–	0	0	0	0
Soil, bedrock and groundwater	0	–	–	–	–	0	0	0	0
Noise	0	– –	– –	– –	– –	–	–	–	–
Vibrations	0	–	–	–	–	0	0	0	0
Waterborne transport	0	–	–	–	–	–	–	–	–
Land transport	0	–	–	–	–	–	–	–	–
Air emissions	–	–	–	–	–	–	–	–	–
Land use and built environment	0	–	–	–	–	–	–	–	–
Landscape and cultural environment	0	–	–	–	–	–	–	–	–
People and society	0	–	–	–	–	+	+	+	+
Natural resources	0	0	0	0	0	–	–	–	–
Waste	0	–	–	–	–	–	–	–	–